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ABSTRACT

A resource handbook for rural Alaskan teachers covers village science, to make basic science concepts relevant to the physical environment in villages. Material is intended for use as filler for weeks that come up short on science materials, to provide stimulation for students who cannot see the relevance of science in their lives, and to help students live more productive, less frustrating lives through understanding their surroundings. The book is arranged as a series of mini-units which can be used in any order, each containing text with illustrations, one or more suggested activities, and student response sheets. A preliminary section defines basic concepts: friction, surface area, inertia, action/reaction, centrifugal force, and center of gravity. The first units cover the sciences of boats, piloting boats, outboard lower units, outboard cooling systems, spark plugs, compression in engines, and carburetors. Subsequent units discuss the sciences of chainsaw clutches, snowmachine clutches, snowmachine tracks, gas lamps, wood stoves, and vapor barriers in houses. Other units explain the sciences of nails, handtools, sharpening tools, goldpanning, cutting down trees, and cutting fish. The final units illustrate the sciences of skates and steel sled runners, dog sleds, snowshoes, airplane floats, guns, generators, speakers, cassettes and radios, and eating foods. (MH)

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Village Science

A RESOURCE HANDBOOK FOR RURAL ALASKAN TEACHERS

ED230618

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VILLAGE SCIENCE

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Alan Dick

Iditarod Area School District
June 1980

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THE SCIENCE OF CASETTES AND RADIOS

THE SCIENCE OF EATING FOODS

INTRODUCTION TO THE TEACHER

There is a need for students to realize that the science found in glossy textbooks is the same science that makes sense out of the physical environment in the village. Things work or don't work for the same reasons in village Alaska as they do anywhere else in the world. Only the setting is different.

The material in this book has been chosen for the purpose of demonstrating some of the basic science concepts as they relate to village life. There are many other topics that could demonstrate the concepts. There are many concepts that weren't dealt with. Relevence to village life and the limitations of the author dictated the material.

The vocabulary has been kept as basic as possible. The hope is that this material can be used as follows:

1)Filler for weeks that come up short on science materials

2)Stimulation for students who can't see the relevence of science in their lives.

3)A help to the students to live more productive, less frustrating lives through understanding their surroundings (the true purpose of science).

The book is a series of mini-units which may be used in any order, although they are grouped loosely by topic. Within each unit is a text with illustrations, one or more suggested activities, and a student response sheet. It is hoped that other tests or follow-up work will be prepared by the teacher. This material is aimed at any young person who might profit from it. Teachers might want to design some specific activities that individually suit students' needs.

This work will be a success if students start using the concepts in other parts of their lives.

Sincerely,

Alan Dick

Concepts

The following are some concepts that are basic to understanding science anywhere in the world. With an understanding of them, it is possible to figure out many of the common things which happen daily.

Friction-

Friction is the resistance, the holding back, between two moving things that are pressing together. When we drag a log over the ground it has great friction. The force that is holding back is friction. If that same log is peeled and slid over smooth poles,the friction is made much less. The weight of the log is about the same, and the distance it is moved is the same , but the friction is reduced. And that makes the log much easier to move.

There is no motion on the earth that has no friction. Sometimes we try to avoid it. In an engine, friction would quickly wear out the parts if oil didn't lessen the friction. Sometimes we need friction. The brakes on sleds and snowmachines have great friction to keep us from crashing into trees and each other. Shoes are made to have high friction to keep us from slipping. So, friction can either help us or hurt us. Knowing about it surely can make our lives less frustrating and more fruitful.

Surface area-

Surface area is the amount of space that is showing to the outside of something. Close your fist. How much of it can you see? Open your hand. How much of it can you see? Certainly there is more surface area showing when your hand is open than when it is closed.

Surface area is important for the understanding of two different things. The first is heat loss or gain. Heat is lost only from the surface of things. The greater the surface area of something, the greater is the loss of heat from it. When your hand is cold don't you close it up inside your gloves? This is to lessen the surface area that your hand can lose heat from. When you are cold at night, don't you curl up? This lessens the surface area that you can lose heatfrom. We can increase the surface area of something to increase the heat loss too. This is why the head of snowmachines or chainsaws has fins.

The greater surface area allows heat to escape, and lets the engine cool fast enough. For the same reason rabbits have big ears to help them cool off in the summer.

The second reason we need to know about surface area is to understand pressure. If we put our weight on a pair of snowshoes we aren't likely to sink into the ground. What if we put our weight on a nail? Of course the nail will sink into the ground. Has our weight changed? No. The surface area that our weight is spread over has changed. We can talk about this in pounds for every square inch. If all of your weight is put on one square inch, you might be putting 65 pounds on one square inch. But if your 65 pounds is put over 24 square inches, then there is only about 2 1/2 pounds for every square inch. Has your weight changed? No. But the area you are spreading it over has changed.

Because we are lazy to write too much, scientists call "pounds for every square inch" "pounds per square inch" or easier "p.s.i." If we put our weight on a narrow knife blade that doesn't have even one square inch of surface, the pressure in psi is tremendous, even though we are light. This is the idea behind a knife or other cutting edge. Lessen the surface area, and this makes the psi so much higher that the edge sinks in.

It is for these two things that we need to understand surface area, for:

1)heat loss and gain
2) pressure in psi

Inertia

We have been using and fighting against the law of inertia all of our lives. The law of inertia says that something that isn't moving will stay stopped until it is moved by an outside force, AND it also says that something that is moving will keep moving until it is stopped by an outside force. A sled that is stopped will stay stopped (until it is moved by an outside force.) The heavier the sled is, the harder it will be to get going. A snowball that is flying in the air will keep flying until it is stopped by an outside force, like your head. The heavier the snowball is, the harder it will be to stop. This is pretty simple to understand.

Something else important to think about is the speed something is going. The faster something is going, the harder it is to stop, and the faster we want to get something to go, the more force we must use to get it going fast.

Action=reaction

Action=reaction means that for everything that happens, there is an equal and opposite reaction. The most common example of this is a gun kicking. The action is the bullet flying out of the barrel, and the reaction is the gun kicking our shoulder. Pulling a bowstring back is an action, and the arrow flying off in another direction is the reaction. The rocket

blasting hot gasses out the back is the action, and the rocket lifting off towards the moon is the reaction. Sometimes the action and reaction don't happen together in time. We open the jaws of a trap. That is the action. Perhaps a week later a marten steps on the trap, and the reaction takes place. The jaws close again that is the reaction. But for every action there is an equal reaction.

Centrifugal force

When something is spinning, there is a force that makes all parts try to fly from the center. Spinning an airplane around on a string is the best example of centrifugal force. The faster it spins, the stronger is the force for the plane to fly away. Really, this is the law of inertia at work. When something is moving it will keep moving IN A STRAIGHT LINE if it can. Centrifugal force is the force of inertia pulling against the string as the plane tries to fly in a straight line away from the center.

Center of gravity

The center of gravity is the place in an object where it would balance if hung from a giant string. There is as much weight on one side as there is on the other. There is just as much weight above this point as there is below it. It could be called "the middle of the weight".

With these simple science concepts, it is possible to understand much of the world around us. Certainly there are more concepts to learn, but having fun with these will hopefully get students trying to discover the others on their own.

SCIENCE OF BOATS

There are basically two kinds of boats:

1) planing boats

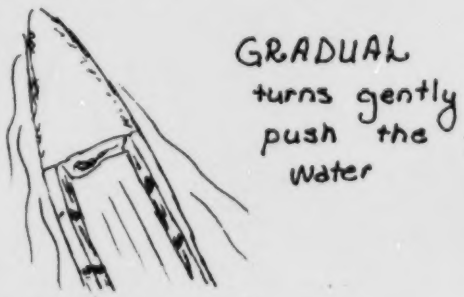
2)displacement boats

Both kinds serve a real purpose, and neither is better than the other unless we have a purpose in mind.

The old timers used to make nothing but displacement boats. A displacement boat doesn't climb on top of the water much but cuts the water smoothly like a canoe. It performs well with even big loads and can operate with a small motor. It is a slower way to travel but a reliable way to carry big loads safely. Most of the newer boats are planing boats. They are better for climbing up on top of the water and buzzing around with lighter loads.

They are even good for carrying big loads, but it takes great horsepower to climb on top of the water with a big load. The new lifestyle doesn't see people hauling huge loads with small motors anymore. Most people have this type of a boat.

A displacement boat must have smooth lines. Its gentle curves must cut the water gradually. Picture putting your hand into water slowly and repeating this, but each time putting your hand into the water faster and faster. Fairly soon your hand will smack against the water and it will take a great force to get your hand even a few inches into the water. The more violently we push the water out of the way, the more resistance the water offers against us. The same thing applies to the lines of a displacement boat. If the lines are abrupt, then the boat is pushing the water out of the way too suddenly, and there will be much resistance to the boat entering the water. If the lines of the boat are gentle then the water is pushed out of the way gradually, and there is less resistance to the boat traveling through the water.



With the same motor, and the same load, a boat with gradual lines will travel faster than one with sharp bends and curves. A planing boat is made to buzz around quickly and to carry loads with high horsepower only. Nearly everyone has a terrible story to tell about an overloaded trip that took seven times longer than it should have. This is usually in a planing boat that can't get up and plane. A planing boat is like a raft if it cannot plane. It seems that the secret of having a good planing boat is to make it wide. It is the width that lets it climb up. It can climb up on top of the water for the same reasons described above. Picture again putting your hand into water,

faster and faster and faster. The more violently we react with the water, the more "solid" it seems to become. A planing boat travels fast enough over the water that the water doesn't have time to move out of the way, and the boat stays on top. As soon as the boat slows down, it sinks deeply into the water.

A serious consideration with either a planning boat or a displacement boat is the friction between the boat and the water. Friction slows the boat down greatly. If the boat is slowed, then more time and gas are used in getting from one point to another. Every effort should be made to smooth the bottom and sides of a boat. Although we can't feel a great drag on the boat, over the course of a summer there are cans and cans of gas wasted because the rough bottoms of boats slowed them down so much.

A boat that has a flat bottom will climb up on top of the water much more easily than one that has a V bottom or round bottom. But a round bottom or V bottom boat will cut waves smoothly, where a flat bottomed boat will pound the boat and contents.

There is really no ideal boat. Sometimes we need a light boat to buzz around, and sometimes we need a good displacement boat to carry a huge load slowly but surely from one place to another.

When we build or buy a boat, we should think about what use we are going to put it to.

SUGGESTED ACTIVITIES

1. Go and look at the different boats in the village. Students should be able to identify a planing boat and a displacement boat.

How would a planing boat act with a 6 h.p. engine? Would it be a displacement boat? Would it be a good one?

Look at the lines of a canoe if there is one. It is a displacement boat. Are the lines gradual? Is it easy paddling? Look at the lines of a planing boat. Would this be easy paddling or poling?

Which would be easier to tow home if the engine quit- a planing boat or a displacement boat? Look at the bottoms of the boats in the village. Which ones will have the most friction? Ask around the village to find how the old folks used to get the "hair" off the bottoms of the wooden boats.

2. Students should gradually put their hands into the water, and then do it faster and faster. Does the water seem to get more "solid" as it is struck harder? What is the connection between this and a boat planing? Could it be said that at a

certain speed the inertia of the water moving out of the way is so great that the water becomes "solid" enough for the boat to climb on top?

Students could carve or draw their choice of a displacement boat or a planing boat.

Student response to "Science of boats"

There are basically two kinds of boats. What are they?

Which of these two kinds of boats is better for carrying a load with a small motor?

Which of these two kinds of boats is better for buzzing around?

If you were designing a displacement boat, what would be the most important thing to remember?

A planing boat is better when it is wide or slim?

The bottom of a boat is rough, what is the force called that slows the boat down?

Which kind of a planing boat is better for climbing up on top of the water, one with a flat bottom, or one with a V bottom?

Which kind of a planing boat is better for climbing up on top of rough water, one with a flat bottom, or one with a V bottom?

If you were to design a planing boat for your area, how would you design it?

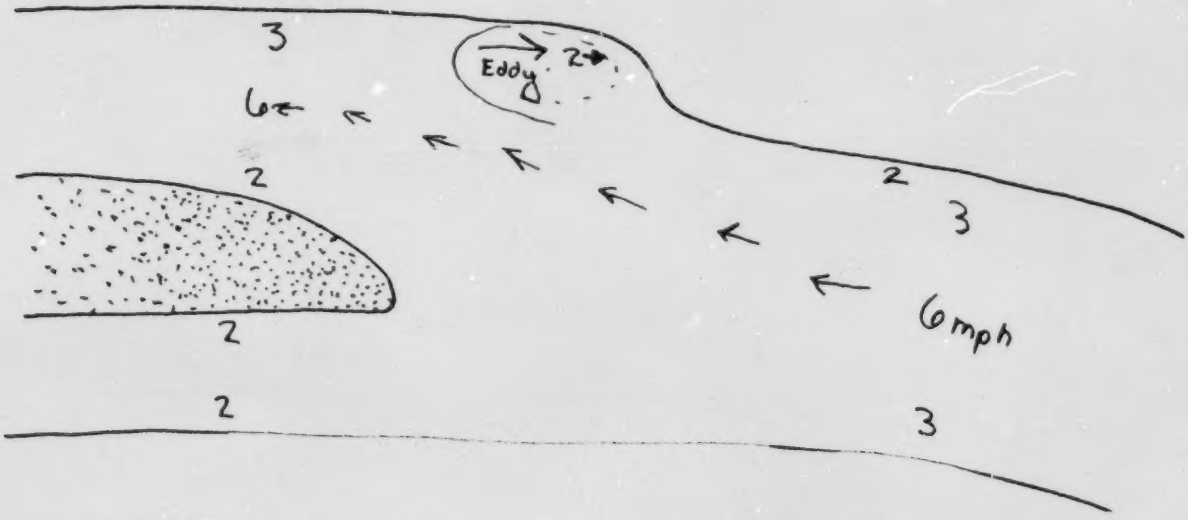
SCIENCE OF PILOTING A BOAT

Concepts: inertia, friction

There are many people living up and down Alaska's rivers. On every river there seems to be someone who really knows how to pilot a boat, and then there are some people who qualify as prop smashers. The folks who know how to pilot well are quick to show off, and slow to teach. Once we learn how to read, we realize that some books are harder to read than others, but it is possible to read all books. Once we understand how to read a certain river and the forces at work there, A person can read another river too.

An experienced pilot can go from one place to another with the same boat and load as an inexperienced pilot and make the trip faster.

How is that possible?



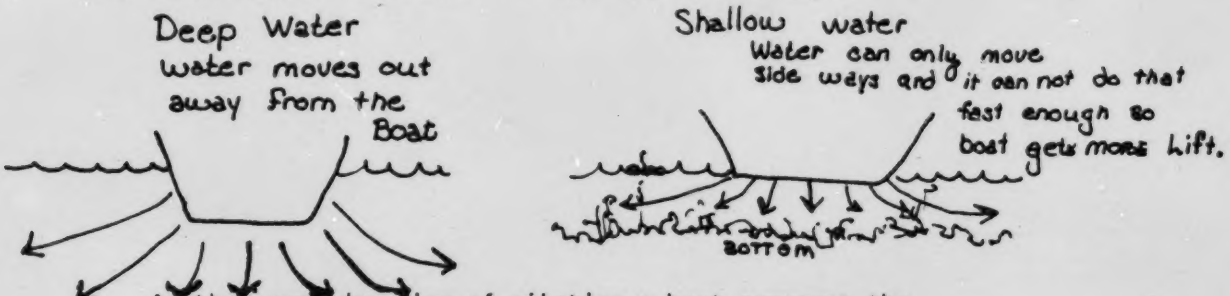
We all know that the current is slower close to the bank than it is in the middle of the river. Friction with the riverbanks slows the current down. The flow of water in the middle of the river isn't slowed by anything. At any one point on a river, the current will be going at different speeds. A good pilot travels upstream taking advantage of all the slack current he or she can. Eddies are places where the water swirls backwards. Besides being a good place for a set net, eddies can give a tremendous push upstream. Even against a cutbank, the current swirls backwards against the bank. A good pilot travels upriver very close to the shore taking advantage of the back currents. The current might be 6 miles an hour in the middle of the river, but it can be 1-2 miles an hour in the turbulence against a bank. In an eddy it is possible to go WITH the current while going upstream.

The current will also swirl behind rocks and snags. These swirls will also help a boat upstream even if the surrounding

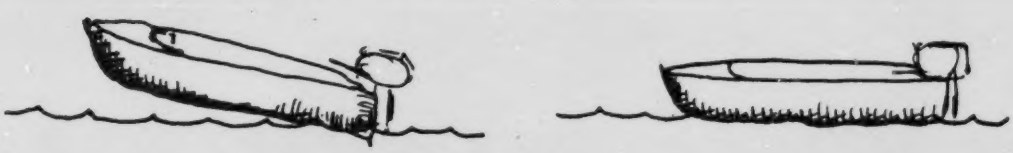
water is swift.

As a pilot moves upstream he has to decide whether the "helps" that the river has to offer are worth it all the way. Obviously it isn't worth it to go across a wide river to get a little push from an eddy. The pilot must also decide whether the helps are more dangerous than they are worth. The swirling current against the cutbank might be really a great help, but if the sweepers and stumps make it dangerous then it might be better to ride the shallow place on the sandbar across from the cutbank.

A good pilot knows that a boat lifts when it travels over shallow water. The pilot can hear his motor speed up. This is really handy if we are traveling almost to the limit of our boat's ability to plane. But it takes a good pilot to travel shallow enough to get lift, and deep enough not to wipe out. In the following picture you can see how a boat gets lift in shallow water. This is exactly the same as "ground effect" for an airplane, but better as water can't be compressed like air can. In deep water, the boat presses down, and the water moves down and away with lots of room for the water to move to. In shallow water, the water can move sideways, but this takes time, and it can't move downward, because the bottom is there. So as we travel over shallow water the boat gets much more lift because the water doesn't have time to move out of the way.

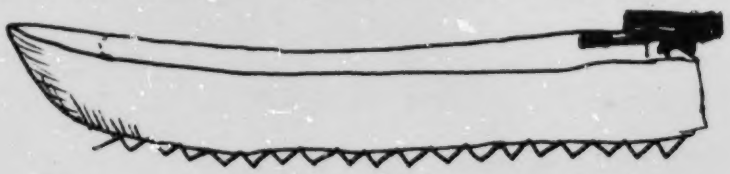

Deep Water
water moves out away from the Boat
Shallow water
Water can only move side ways and it can not do that fast enough so boat gets more lift.
BOTTOM

Another consideration of piloting a boat concerns the friction of the boat against the water. If the angle of attack of the boat is too steep it is plowing water, and can't travel too fast. If the angle of attack of the boat is too flat, then there is too much surface area between the boat and the water, and friction is increased.

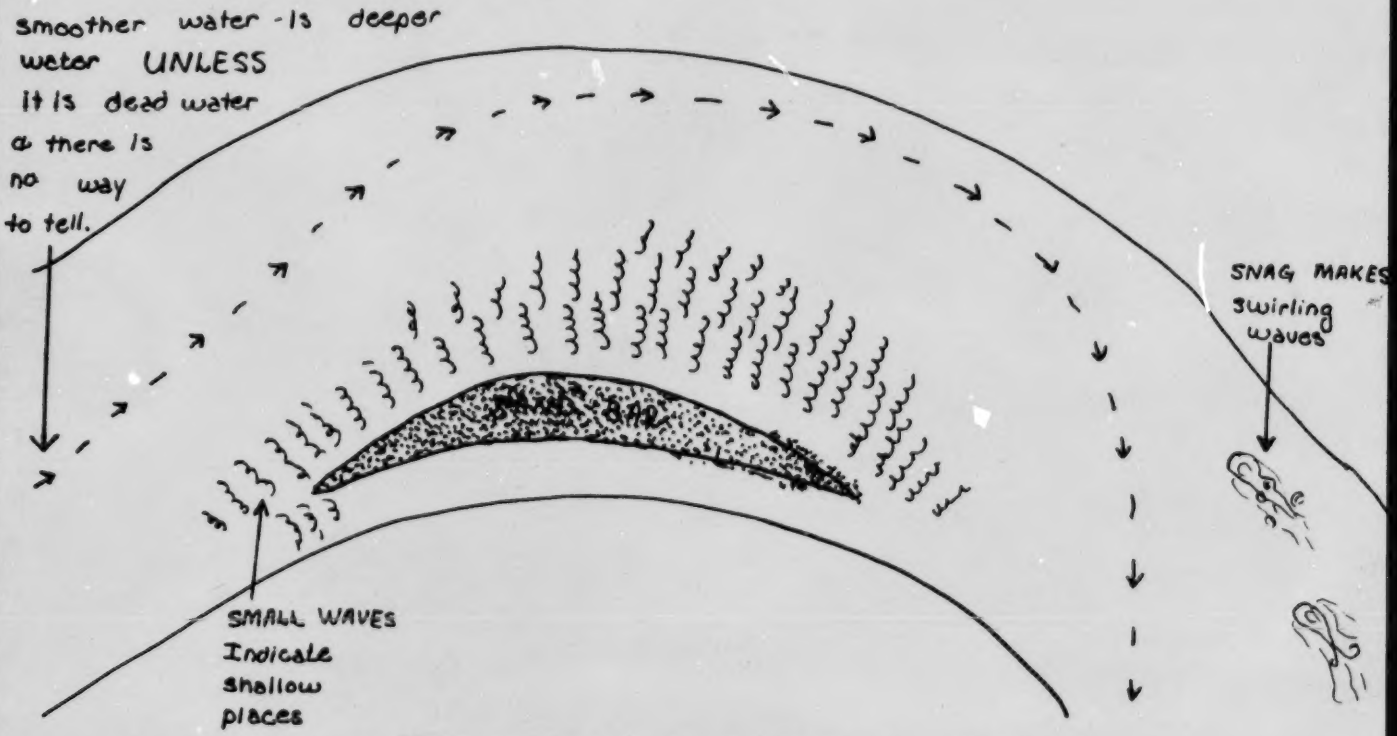


A good pilot also recognizes that while big waves bump against a boat too hard, and hold it back, small waves provide a great number of air pockets under the boat. This lessens the surface area in contact between the boat and the water, and

therefore reduces the friction. How much is gained by this depends on how smooth or rough the bottom of the boat is.



It is very hard to tell where the channel of the river is when it is windy. (This is the excuse to use if you wipe out- "it was too windy to see the channel good.") This is the same as trying to read a book in the dark. But if there isn't too much wind, we can tell the shallow places from the deep places by looking at the waves. The shallower the water is, the more it will show those tiny waves that warn us away. Of course, these waves will show more when the current is swift, or when the bottom is rough gravel rather than mud. Snags and rocks will show more when the current is swift. So if the current is slow, and there is a sign of something underneath, chances are that the obstruction is close to the surface.


Smoother water is deeper water UNLESS it is dead water & there is no way to tell.
SNAG MAKES swirling waves
SMALL WAVES Indicate shallow places

Certainly there is no better way to learn how to pilot the river than to travel the river. However, it doesn't do much good to hit bottom time and again, or to pass by the many helps the river offers. Hopefully people will take pride in their piloting once they learn how to read the river and pilot as well as the old folks.

SCIENCE OF PILOTING A BOAT
Suggested activites

This is best done by doing it. A smaller swifter river is easier to read than a large slower one. Check the current close to the bank, and farther out. Check the current by the sandbar side. Check the current in an eddy or behind a stump or snag. Throw a stick into the water at these different points. How quickly the stick drifts a given distance should indicate the relative speeds of the different places.

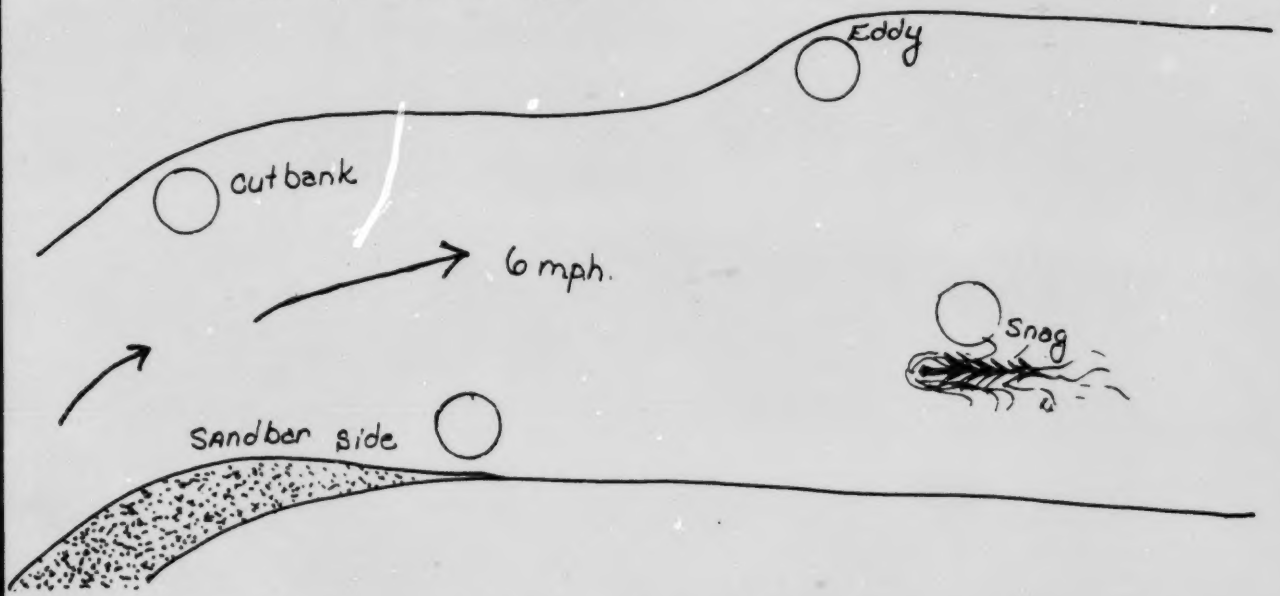
Run a boat in deep water just fast enough to plane. At the same throttle setting, go close to the sand bar so that there is lift from the shallow water. Does the engine sound indicate the increased speed from the lift?

Drive a boat upstream through an eddy and into the current. Is it possible to feel the push of the eddy? Set the engine tilt so that the angle of attack of the boat is pretty flat. Can the drag of the boat be felt? Change the angle of attack of the boat so that the bow of the boat is very high. Is it clear that plowing is also a waste of power? (This is also dangerous in high winds as the boat blows around a great deal). If possible, travel from a sheltered place with no wind and waves onto a place that has a good breeze, and small waves. Is the added speed noticeable? Is it possible to see the small ripples caused by shallow water? Is it possible to see the channel as the smoother, swifter, and deeper water? Anyone who is unsure of the channel can test the depth with a willow about 3-4 feet long.

Student response to "Piloting a boat"

Why is the current next to a river bank slower than the current in the middle?

In the following picture, tell how fast you think the water might be going in the different places circled if the current in the middle is 6 miles an hour.



Draw a picture showing why a boat gets more lift in shallow water.

Draw a picture of a boat with the angle of attack too steep.

Draw a picture of a boat where the friction of the bottom will be too great.

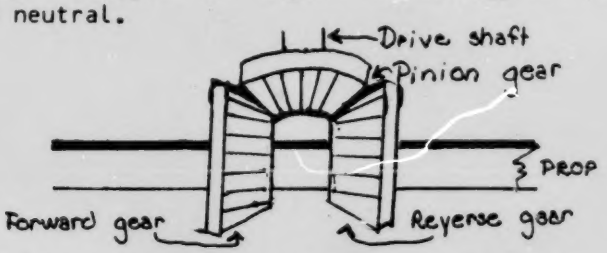
Why do small choppy waves help the boat travel a little faster?

SCIENCE OF AN OUTBOARD LOWER UNIT

Concepts: inertia, friction, action=reaction

It would be nice if we didn't have a lower unit hanging under the boat to smash rocks and stumps and create drag against our forward motion. Some people have gone to jet units, but most of the people on Alaska's rivers still use long and shortshaft outboards.

The power that comes from the power unit is spinning in one direction, and the prop shaft and prop need to spin a direction 90 degrees from this. There are three gears in a lower unit, the forward gear, reverse gear, and the pinion gear. The pinion gear is on the end of the drive shaft. It meshes with BOTH the forward and reverse gears at the same time. The three gears are ALWAYS turning as long as the engine is running, even when the engine is in neutral.

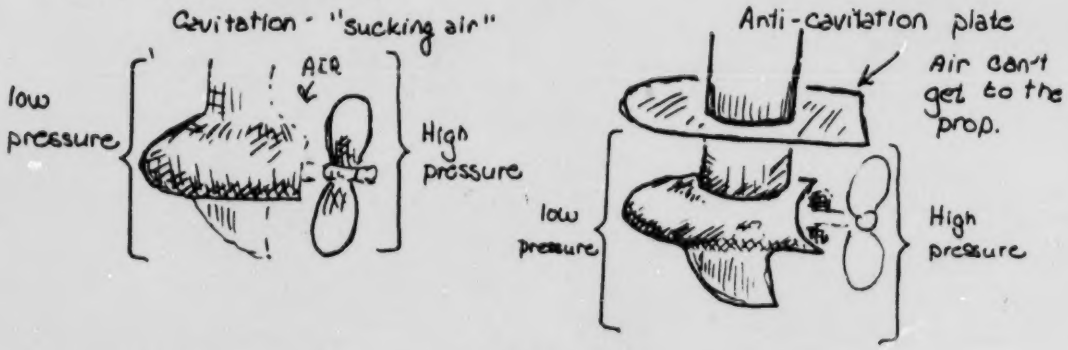


As the pinion gear is smaller than the forward and reverse gears, it turns more times than they do. As it is smaller than the forward and reverse gears, it is also the one to smash if we hit the bottom too much. The pinion gear turns about 2 1/2 times every time the forward and reverse gears turn once. The drive shaft and pinion gear are turning about 5,500 rpm (revolutions per minute), so the forward and reverse gears and the prop shaft are turning about 2200 rpm. "Wait a minute," you say. "How can both the forward and reverse gears turn at the same time and not fight against each other". The answer is that they are not connected to the prop shaft at the same time. On the prop shaft there is a piece of iron that has "dogs" that mesh with either the forward gear, reverse gear, or neither, as in neutral. These dogs are heavy and hard to chip. If the gears went in and out of each other every time we shifted, they wouldn't last long at all. Shifting into gears while the engine is going fast is hard on the heavy dogs too.

The lower unit needs to be full of lower unit grease. It is important to use the right kind of grease. If the grease is too thin, there isn't a protecting layer of grease between all of the moving steel parts, and there is rapid wear. If the grease is

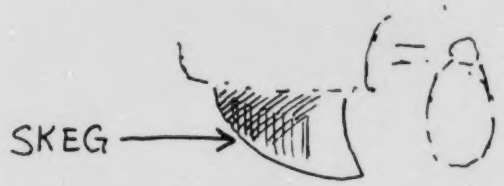
too thick, then it isn't able to flow into the small places between bearings and gears, and there is great wear in these places. Every lower unit ends up with some water in it, and only lower unit grease can mix with the water and still lubricate the lower unit properly.

Where the drive shaft and shift shaft go into the lower unit, and where the prop shaft goes out, there is danger of water entering the lower unit. At each of these points there is a rubber-like seal that does the job. Sometimes these seals wear out, and there is a need to change them before the gears are damaged. Above the prop there is a plate. As the boat runs, there should be about 1/4 inch of water over this plate. If the lower unit is too low in the water, it will drag a lot against the forward motion of the boat. As the speed of the boat increases, the resistance is greatly increased (squared), so we cannot afford to have the lower unit too deeply in the water. If the lower unit is too high, the prop will "catch air" or "suck air" or more accurately, "cavitate". The name for the plate is "anti-cavitation" plate. Anti means against, but what is cavitation? Behind the prop there is great pressure, but in front of the prop there is low pressure because water can't rush to the prop quickly enough.

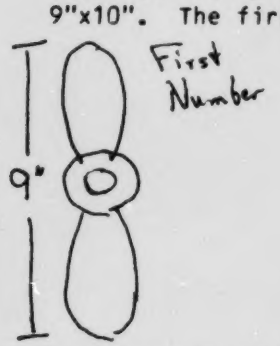


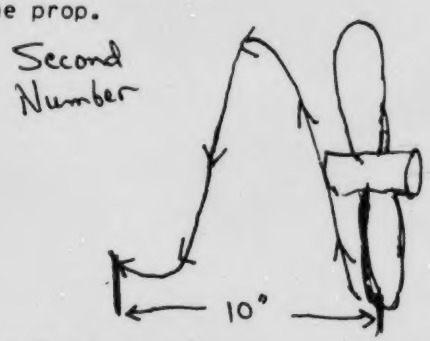
If the pressure in front of the prop is less than atmospheric pressure (14.7 lb/square inch) then the air will rush down to fill the low pressure area in front of the prop. This is cavitation. When it happens, the prop will spin a pocket of air, and there will be very little forward push from it. The anti-cavitation plate keeps the air from rushing down to the prop. It is against cavitation. If it is bent or chipped, the prop might cavitate. Falltime, leaves will get stuck on the front of the lower unit. This will slow the flow of water to the prop, causing a low pressure in front of the prop. It will cavitate even with the anti-cavitation plate when this happens.

The shape of the lower unit is such that it will hold all of the gears, and yet not drag against the forward motion much. The gears could be made bigger and stronger, but the lower unit would be too big and would drag considerably. The skeg hanging from the bottom is to protect the prop from the bottom of the river, and it does a fair job until it is smashed off. Again, it could be made bigger, but it would drag too much.



Props come in different sizes and pitches (pitch is the angle of the blades). Some props have three blades and some have two. On each prop there is usually two numbers like 11"x11", or 9"x10". The first number is the diameter of the prop.



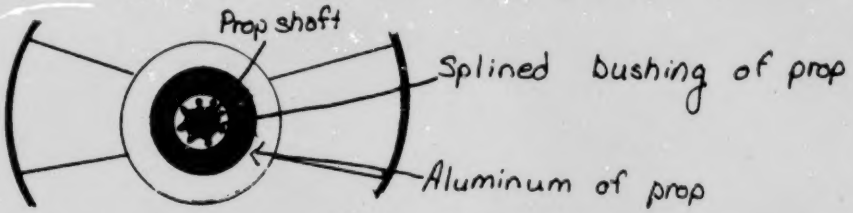


The second number is how far the prop would travel forward in one complete revolution. So a prop that is 9"x9" has a 9" diameter and will travel forward 9" every time it makes a complete turn. A prop that is three bladed and 9"x9" is a working prop. It doesn't try to push the boat ahead very far each turn but tries to push steadily against the water (with three pushing blades). A prop that had two blades and was 9"x11" would be a good speed prop. It wouldn't have as much pushing power, but would be able to push the boat fast over the water.

If we try to use a speed prop for load, there will be a great strain on the engine, which will never be able to get up the proper rpm to run right. If we use a load prop on a light boat, then the engine is turning over too fast. This also puts a strain on the engine as the piston races up and down. Pistons are made of light aluminum so that their inertia won't tear the

engine apart, but when an engine goes too fast, even the aluminum piston puts a terrible strain on the system. On an outboard motor, the load controls the engine speed. Too much load causes strain on the engine, as does too little load.

As props hit the bottom of the river or hit logs, something has to give. Action equals reaction. If the rock doesn't move, and the motor doesn't jump off the boat, then something between the prop and the driving pistons MUST give. For the action of crashing, there must be a reaction somewhere. Some motors have shear pins, which break and keep the gears from taking all of the strain of a crash. But people found shear pins a bother, and now most of the new motors have slip props. They are designed like this:



The inside of the prop is held to the prop shaft by the splines on the shaft. The prop shaft and the inside of the prop can keep turning and the outside of the prop can slip against the rubber if it hits something. The reaction takes place in the rubber of the prop instead of in the gears or motor parts where expensive damage could result. This works fine until the rubber gets worn, and then there isn't enough friction between the rubber and the prop. The rubber slips even when the motor doesn't hit anything.

In all, lower units are a necessary part of the outboard. They could be made stronger, but they would be bigger and would drag more. They could be made to drag less but would be too weak. Nearly every Alaskan villager has had lower unit or prop trouble somewhere along the river and has wished that they were made differently.

SCIENCE OF AN OUTBOARD LOWER UNIT
Suggested activities

Students could try to rapidly push their hand through the water to appreciate the drag that a lower unit has. Does this explain why we don't put the lower unit any deeper in the water than we have to?

A lower unit that is washed well with gasoline will show all of the moving parts. Do all of the gears turn at the same time-forward, reverse, and pinion? Turn the drive shaft. How many times must the drive shaft and pinion gear be turned to turn the forward gear once? Find the dogs on the drive shaft. Move it back and forth on the shaft into the forward gear, reverse gear, and neutral. What can you say about lower unit grease after trying to wash out the lower unit? Inspect the seals that go around the prop shaft where it emerges out of the lower unit. Can you find the spring that gently squeezes the rubber around the shaft? It is impossible to duplicate cavitation without complicated test equipment, but it should be discussed as the lower unit is in hand. The cavitation plate is more than a splash guard. Measure the diameter of the prop. Does your measurement match the numbers on the prop? Or has the prop been worn down?

Try imagining the prop twisting its way into the water. Does the second number on the prop match your imagining? Would the prop auger that many inches forward?

Does the roughness of a used prop affect the friction between the prop and the water? Look at the prop. From the forward side of the prop, is it plain how the rubber lets the prop slip when something is hit?

Student response to "Science of an outboard lower unit"

Which gear is on the end of the drive shaft?

Do all three gears turn at the same time, or are only the forward and pinion gears turning while the boat is in forward?

Which turns faster, the pinion gear or the forward gear?

Do the gears move in and out of each other when the gears are "shifted"?
What is happening then?

Tell some things about lower unit grease, including the thickness (viscosity).

What keeps water out of the lower unit?

What does the anti-cavitation plate do?
What does this tell you about the pressure behind and in front of the prop?

What would the numbers 9"x10" tell you about a prop?

What is it about new props that make shear pins not needed?

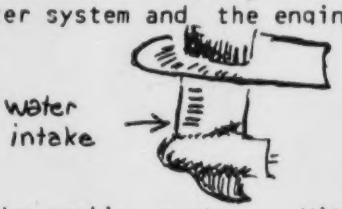
SCIENCE OF AN OUTBOARD COOLING SYSTEM

Concepts:friction

An outboard motor runs at a constant temperature once it is warmed up because it is cooled steadily. The water flows around the cylinders and exausts out of the lower unit. Without the water cooling the engine, it would overheat in a very short time, do damage to the engine, and stop. As engines are not like people, who can heal, it is important to keep the damage from happening.

The water comes into the lower unit differently in different engines, but generally there are holes, or a large hole with a screen that allow the water to come into the front of the lower unit.

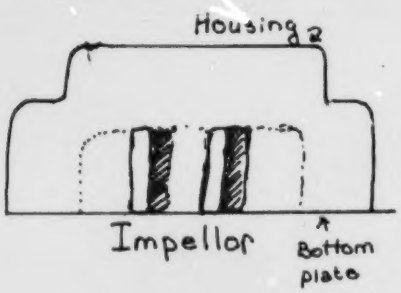
If the holes were too large, or if there was no screen, then rocks and grass could plug up the water system and the engine would overheat and cease up.

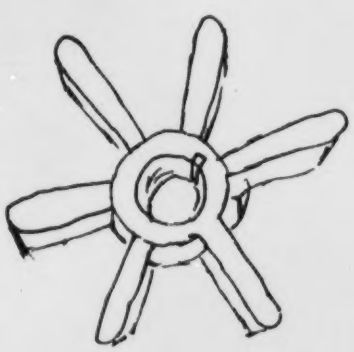


The water pump is the heart of the cooling system. Without it, cooling can't happen well at all. There are three parts to the pump:

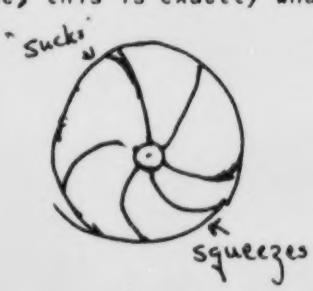
1)the bottom plate
2)the impeller
3) the top plate or housing

See the pictures below.



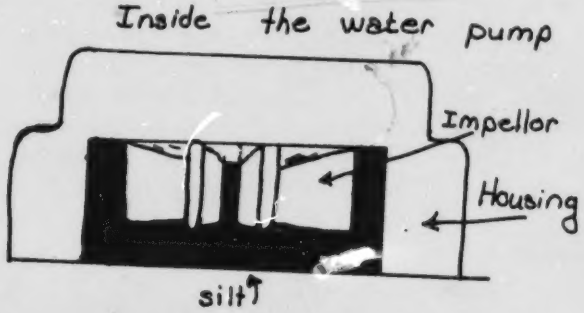


The water pump works like this-
One side of the housing is bigger than the other. As the impeller turns around (the key holds it to the shaft) the water is easily forced into the side where the area is getting bigger. You might say that it "sucks" the water up from the lower unit. But as the impeller turns around there is less room on the other side. Where can the water go? No place but up to the cylinder. Of course, this is exactly what we want.



There are a couple of considerations about water pumps. Many of Alaska's rivers are silty. So as the water pump is pumping water, it is also pumping silt, which wears out the impeller and housing. Some outboards have soft housings that can wear out fast. Once they are worn, they are sharp enough inside to cut the impeller. It is possible to buy chrome plated housing and bottom plate, but they are expensive. One way to avoid water pump wear is to pull your motor up on "tilt" every time you stop for a while.

When we stop with the motor down, the water pump has water in it. If the water is silty, then the silt will settle out. When we start the motor again, the impeller is grinding in the silt. Doing this once or twice or even several times won't hurt terribly, but if we do this all of the time it will wear the impeller out very fast. People who live on clear rivers very seldom have problems, and their water pumps can last for years.



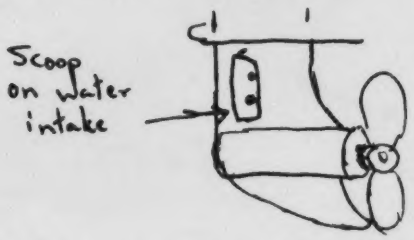
It is very damaging to a water pump to run it while the motor is in mud. Everyone gets stuck on a mud bar once in a while, in the dark or when it is windy and the channel isn't clear. Pumping mud should be avoided.

For running around the village, it isn't necessary to carry an extra impeller and housing, but quite a few long trips have been crippled by water pump troubles. With short hunting seasons, it is wise to have an extra water pump in the boat to keep from wasting days.

Between the water pump and the power head, there is a copper tubing that seldom gives problems, unless someone has smashed or lost the rubber seals on the pump or power unit ends.

when an engine overheats, it will cease up because heat causes metal to expand. The piston will expand and actually get too big for the cylinder and get stuck. The piston will contract to its normal size once it is cooled off, but there is great friction between the piston and the cylinder walls before it ceases up. This is where the damage is done. The cylinder walls can be scratched, and piston rings can get stuck.

Water pumps are simple in operation. They must be protected from silt and small gravel as much as possible. Some people tell stories of bolting a scoop on the front of their lower unit around the inlet for water so that water will be rammed past a bad water pump and forced up to the engine. This works in emergencies, but there is no water cooling the engine when there is no forward motion, and the scoop can get plugged with leaves and plants in the water.

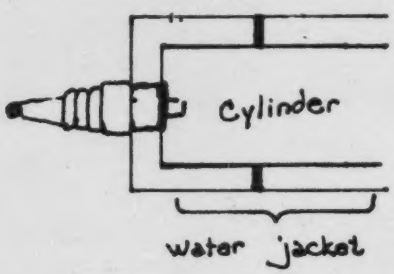


Without a properly working cooling system, an outboard can not only leave you stuck, but it can destroy itself.

As water goes into the power unit it passes a thermostat. Some engines have a reputation for having thermostat troubles, and others don't. The job of the thermostat is:

1)to keep water away from the engine when the engine is cold, and

2) to open up and allow water to get to the engine when the engine is hot. Most thermostat problems have to do with rocks getting through the lower unit and pump and getting stuck in the thermostat. The screen in the lower unit should be kept in good shape. The usual village solution to thermostat problems is to throw it away. Certainly this is better than having the engine cease up from overheating, but the owner has to accept the fact that his engine will warm up slowly. This means wasted gas for the first few minutes of operation.



The cooling water passes in a jacket around the cylinders and exits down through the middle unit and out the back of the middle unit or out of the lower unit through the prop. No matter where the water comes out we need to know whether the water pump is working or not. Most engines have a indicator that sends out a stream of water on the side of the engine. The water that comes out of the indicator is not all of the cooling water! When temperatures are freezing, the indicator can be frozen even though the water pump is still working. How do we know whether the pump is working or not? We don't.

Some people have bailed water onto their motors when the water pump quit. This might work to get someone home, but we have to remember that there is a jacket around the cylinder and that we are cooling the outside of the jacket and not the cylinder walls.

SCIENCE OF AN OUTBOARD COOLING SYSTEM
Suggested activities

Take a water pump apart. Identify the three main parts. Note the key that connects the impeller to the shaft. With the bottom plate off, and the impeller in the housing, put a stick through the hole for the shaft. Turn the impeller. It should be obvious that one side has more area than the other. The larger side is the intake side. The smaller side is where the water is squeezed out, and upward. Does the impeller show wear? Does the bottom plate show wear?

Find the holes in the lower unit below the anticavitation plate. This is where the water goes in. Is there a screen? Check the copper tubing that brings the water up to the power unit. Are there rubber seals where it connects on top and bottom? Look at the power unit.

Can you find the thermostat? If it is okay, take it off and look at it. It should work by a spring expanding and contracting as it is heated or cooled. The movement opens and closes the water flow to the cylinders.

Blow on the water pump indicator. Where does the air pressure come out? Cover that opening if you can, and check where else it might come out.

Is it clear why a water pump that is frozen in the housing will immediately spoil if the engine is run without first thawing the water pump.

Student response to "Science of an outboard cooling system"

What would happen to an outboard if water didn't circulate around the cylinders?

What would happen if the holes for water intake were too large?

What are the three parts to the water pump?

With a picture, describe how the water pump works. Label the side where water comes in and the side where water comes out.

Why should an outboard be pulled up when not being used? This has to do with the water pump.

What is the biggest problem with thermostats?

What is the usual solution to this problem? Why isn't this always the best solution?

What is the thermostat's job?

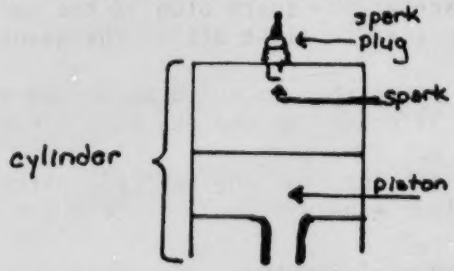
Will bailing water onto the cylinders of an engine cool the cylinders much if the water pump is not working? Why?

SCIENCE OF SPARK PLUGS

Nearly everyone in Alaska has been stuck one time or another because of "bad plugs" . Maybe it was the chainsaw that wouldn't start or the outboard. Sparkplugs are so important to an airplane that there are two of them in each cylinder. If one of them fouls, the other can still work.

In a gasoline engine, the gasoline burns. The job of the sparkplug is to light the gasoline so that it can burn. This can only take place if the spark plug is doing its job well.

The magneto generates electricity. The coil increases the voltage of the electricity, and at tremendously high voltage (about 25,000 volts) the spark jumps across the gap inside the cylinder, lighting the gas that will drive the piston. This sounds easy enough, and it is, but there are some considerations that will get us past the point of saying "the spark plug went dead"

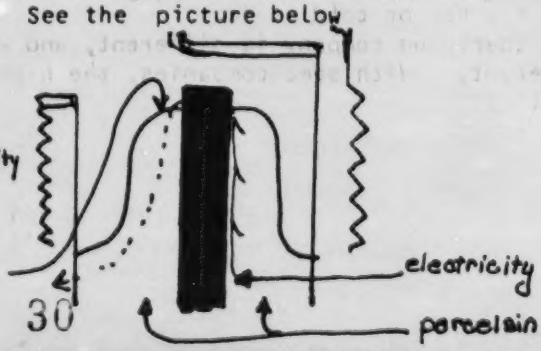


All of the action starts at the gap of the sparkplug, so the discussion can start there. The compression in an outboard or chainsaw is about 7 to 1. That is, 105 pounds pressure on every square inch. A spark that would jump the gap in open air maybe isn't strong enough to jump the gap inside the cylinder. This is why the voltage must be very high. We in the villages have no way of testing the voltage of the spark, but we can tell by the color of the spark. If the spark looks white or blue, then it is strong enough to spark inside the cylinder. If the spark is red or yellow, it is strong enough to spark in the air but might not be strong enough to spark inside the cylinder.

What could make the spark weak? If the magneto or coils aren't working right, and there isn't enough voltage getting to the spark plug, then it will have a weak spark or no spark at all. If the sparkplug is dirty, then it can have a weak spark.

The black stuff in the cylinder is carbon left over from burning gasoline. This carbon is also a conductor of electricity. (The brushes in generators are made from carbon because it is such a good conductor.) The electricity comes from the coil, and travels to the center post in the plug. There is white porcelain around this center post to keep the electricity from going anywhere but across the gap. Porcelain is a very good electrical insulator. See the picture below

If the porcelain is covered with carbon the electricity runs down the side and not across the gap



If the porcelain has a coating of carbon over it, then the electricity that is supposed to jump the gap and light the gas just runs down the side of the porcelain and grounds out on the side of the sparkplug. Instead of jumping the gap, it takes an easier path and runs through the carbon. Is there electricity available? Yes. Is it lighting the gas? No. If the porcelain is cracked, the electricity can travel through an easier path than across the gap of the plug.

If the gap across the spark plug is too wide, it can't spark at all. If the gap across the spark plug is too narrow, the spark is too small in size to light all of the gasoline in time to burn completely.

What could cause the carbon to build up on the spark plug? Usually a dirty plug is caused by the gas or oil not burning completely, which is due to

1)wrong kind of oil for your engine-try a different oil

2)too much oil in the gas-using too little oil is worse, so be careful how you mix, or

3) the spark plug is too cold.

There are many different kinds of sparkplugs, big and little, fat and skinny, cheap and expensive, but the biggest difference in plugs is how hot or cold they are. A hot plug doesn't let much heat escape through its body, and so it stays hotter than another plug. A cold plug lets more heat escape through its body and stays cooler. If your gas/oil mix is right, and your plugs are still fouling, then chances are that your plug is too cold. Remember, it takes three things to make fire:

1)fuel
2)air
3)heat.

The carbon on your plug is wasted fuel. There is enough air in the cylinder, so the problem is that your plug is too cold and there isn't enough heat to burn the carbon off. Listen closely to this: an outboard runs with the cooling water much the same temperature all season long. An air-cooled snowmachine operates at greatly changing temperatures. An outboard can use the same plugs all season. A snowmachine needs to change the plug with great temperature differences. That is important to know about any air cooled engine. The hotter the weather is, the colder the plug we need to use. The colder the weather is, the hotter the plug we need to use. The number on the plug will indicate how hot or cold it is.

Every sparkplug company is different, and all of the numbers are different. With some companies, the higher numbers are the hotter plugs.

If a plug is fouling, it could be due to wrong oil for the engine, too much oil, or TOO COLD a plug. If a plug is too hot it will look pitted and burned. A plug that is just the right temperature will look a light rusty brown. But remember, air cooled engines operate at all different temperatures, and there is no one plug that will be best for all of them.

SCIENCE OF SPARKPLUGS

Suggested activities

Get an old sparkplug and a new one. With the old plug grounded very well, crank the engine over. What color is the spark? Try the new plug. What color is the spark. Try the old plug again. Close the gap a little, and try again. Is there a noticeable difference? Open the gap very wide. At what point does the plug quit sparking? Close the gap back to .025". Burn the spark end of the dirty plug on a gas or propane stove until the plug is a glowing red. Let it cool well, and try it again. Does it work better this time? (Note:this only works well once. The next time it is burned, it will not last long.) Why does this work at all? Could it be burning the carbon off of the plug?

Take a very dirty plug and clean the porcelain, thinking of the carbon as being a conductor that is draining off the electricity that is needed to jump the gap. Does it work better this time?

Compare the sizes of sparkplugs with different numbers. Is it possible to tell the difference between a hot and a cold plug?

Student response to "Science of spark plugs"

Where is the electricity generated?

What increases the voltage?

A spark might jump the gap in open air and not be strong enough to jump the gap in the cylinder. Why is this so?

Does a yellow or red spark shows that the spark is weak or strong?

Does a blue or white spark shows that the spark is weak or strong?

What things could make the spark weak?

Draw a picture showing how a dirty spark plug lets the spark ground out without passing across the gap.

A dirty plug is usually caused by what three things?

What is a hot spark plug, and what kind of weather would it be used in?

What is a cold plug, and what kind of weather would it be used in?

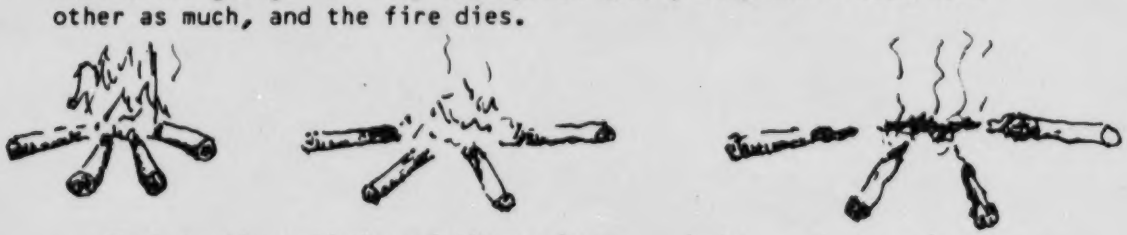
Why would an outboard be able to use the same kind of plug all season, and a snowmachine have to change plugs with big temperature differences?

SCIENCE OF COMPRESSION IN AN ENGINE
Concepts:surface area/pressure

Almost everyone knows that when a head gasket blows on an engine there is a loss of compression. It is easy to understand that the pressures of the expanding gasses on the power stroke are lost. But a loss of compression means more than that.

We all know that it takes three things for something to burn- air(oxygen), fuel and heat. If any of these three things is taken away, then the fire is slowed down or put out.

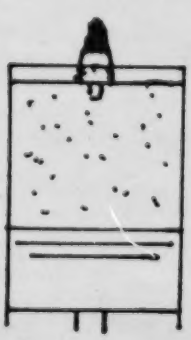
Picture, if you will, a campfire burning strongly. It has all three things necessary for fire. But now picture moving the sticks of the fire farther and farther apart. At some point, the fire will slow down, and at some farther point, it will be nothing but smoking sticks.
The reason this would happen is that the heat of the fire is reduced. Each one of the sticks in the strongly burning fire is warming the others up. All of the sticks provide heat to keep each other going. As they are spread apart, they can't heat each other as much, and the fire dies.

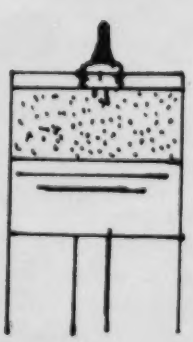


Back to the cylinder of the engine.
As the gas and air mixture come into the cylinder, the gas droplets are rather far apart, but as the piston pushes them together on the power stroke, it is like pushing the sticks of a fire together. When the spark finally gets the burning going, all of the gasoline droplets and air are put closely together. The result is that the gasoline can burn cleanly and quickly enough. An engine turning at 5,500 rpm (revolutions per minute) has a piston that is going up and down almost 100 times a second. You can see that quick clean burning must take place, or unburned gasoline would be pushed out of the cylinder. Diesel engines have no spark plugs. Because pressure makes heat, and the pressure inside a diesel cylinder is so great, the pressure makes enough heat to light the fuel with no spark at all. The pressure inside a diesel cylinder is 16 times the pressure that we live in.

This is fairly simple to understand, but is worth mentioning because any loss of compression due to bad piston rings or head gasket leaks result in a power loss and a gasoline loss.

Not enough Compression. Gasoline drops are too far apart to heat each other up.





Drops are close enough to heat each other up.

SCIENCE OF COMPRESSION IN AN ENGINE
Suggested activities

Make a campfire. Spread the sticks of wood apart. Is the fire burning? Bring the sticks together. Is it burning now? Bring the sticks closely together by laying them parallel. Does it burn harder? Can the relationship of the campfire and the space between gasoline drops in the cylinder be understood?

Check a diesel engine. Are there sparkplugs? How does it fire?

Student response to "Science of compression"

What three things does it take for something to burn?

If a campfire is burning too slowly, what can you do to make it burn faster besides adding more wood?

Draw a cylinder with the fuel not compressed.

Draw a cylinder with the fuel compressed.

How many times a second (about) does a piston go up and down when the engine is going 5500 rpm?

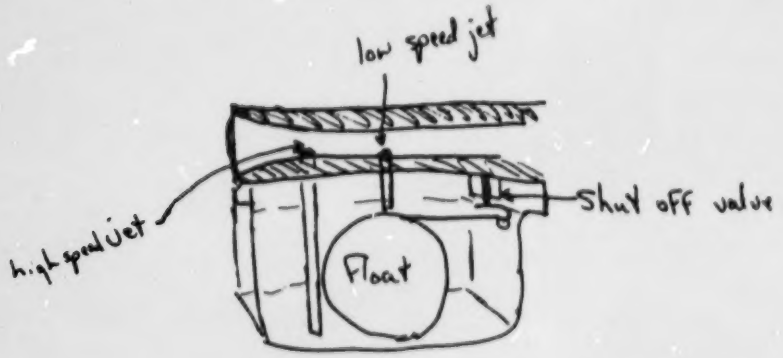
What can cause compression loss?

SCIENCE OF CARBURETORS

Concepts: surface area

Almost every gasoline engine in Alaska has a carburetor. Although carburetors do a simple job, they are often complicated. There are good reasons for this.

The job of a carburetor is to mix the gasoline and air in the right way so the gas can burn efficiently. If engines always ran at the same speed, they would have a simple carburetor. What complicates things is that the amount of gasoline and air are different at different speeds. If an engine gets too much gasoline, it will carbon up fast and will lose power. If an engine doesn't get enough gasoline, it will fade, lose power, and overheat.



Air, luckily enough, is still free. A good air cleaner will make sure that no dust and blowing sand get into the engine to grind the piston and cylinder. If the air cleaner is dirty, the engine will tend to "suck" more gas to take the place of the air that couldn't get through in time. This causes a loss of power and gas dollars. Often we treat an air cleaner like a piece of junk, but it really helps an engine.

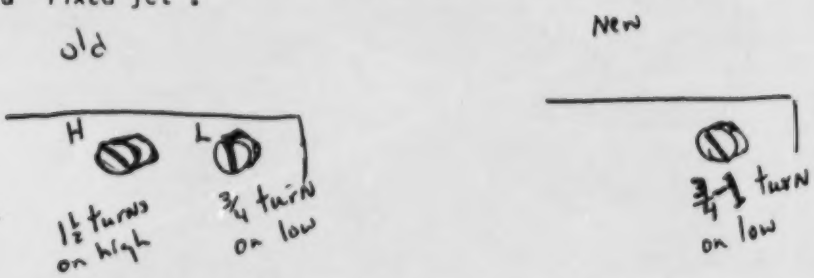
Carburetors are all made differently now, although the idea behind them is much the same. When the engine is going at a slow speed, there is a gentle flow of air over the "jet" that the gas comes from. When the engine is going faster, the flow of air is directed over the "jet" and gas is drawn from the jet. There are two jets: one for high speed and one for low speed.

The choke is usually another control within the throat of

the carburetor.
There is a jet that air can be directed over that will allow a very rich mixture of gas and oil to get to the cylinder. This is good for starting a cold engine but is too rich on gas to run smoothly. Almost everyone has come home with a messed-up carburetor running on half choke. The choke can get more gas to the cylinder but not in accurate amounts.

How do the jets in the carburetor work? As air is pushed into the cylinder, it rushes past the jets. As it rushes past, the air is moving as in the drawing. There is a low pressure area at the point where the gas comes out. The gasoline rises to fill this low pressure area and is then carried to the carburetor.

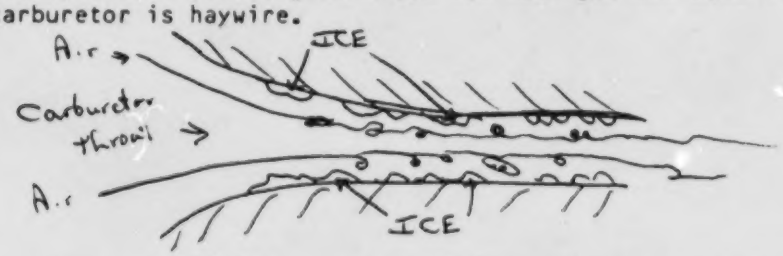
There used to be two needle valves: one for the high speed and one for the low speed jets. These might need adjusting from cold weather to hot weather. Many engines are now made with only low speed needle valve adjustments. The high speed adjustment is now a "fixed jet".



The job of the carburetor isn't only to mix the gas and air in the right mixture, but to break the gasoline into as small droplets as is possible. Which burns faster- a stick of wood, or that same stick carved into shavings? Obviously the shavings. It has more surface area to burn. If the gasoline entered the cylinder in large drops, it would take a long time to burn, so long in fact that it would be pushed out of the cylinder before it was burned completely. Something has to be done to let the gasoline burn steadily and quickly enough to push the piston on the power stroke. The way this is done is to break the drops of gas as small as possible through the fine jets. The gasoline becomes a vapor (like steam). It is so finely mixed with the air that it can burn efficiently.

This can present problems in airplanes and even outboards in

fall time. It takes heat to turn a liquid to a vapor. (Doesn't it take heat to turn water to steam?) As the gasoline leaves the jet it turns from a liquid to a vapor. This takes heat. Where is the heat coming from?It has to come from the carburetor. So it is possible for a carburetor to freeze when the outside temperature is 50 degrees. Air at 50 degrees has moisture in it. When that moisture hits the freezing temperatures of the carburetor, it turns to ice. The ice slows the flow of air to the cylinder. The engine draws too much gas and acts like the carburetor is haywire.



Most snowmachines now have float carburetors, as do washing machine engines, outboards and most airplanes (some planes have fuel injection). The float is a shut off valve. A fuel pump or gravity bring the fuel to the carburetor. The carburetor has to have some way of shutting off extra fuel. The float does this. As soon as the gas level gets high enough, the float lifts and shuts off the gas. As soon as gas leaves the float chamber, the float drops, and gas can come into the float chamber. "Well, why don't chainsaws have this?" we might ask. They could if they operated right side up all of the time. But as we are using chainsaws in all directions, they need a complicated carburetor that is too hard to describe here (or anywhere).

Generally, if something is wrong with an engine, it is due to gas line problems, electrical problems, or major problems (like a broken piston, or reed valve). Trouble-shooting an engine brings us in constant contact with the carburetor. However, carburetors are so well designed that seldom is the problem theirs. Dirty gas, water in the gas, and ice in the carburetor are the most common problems. None of these can be blamed on the carburetor.

Suggested activities SCIENCE OF A CARBURETOR

Get a carburetor. Identify where the gasoline goes in. Take it apart, and check the float (if it has one). How is the flow of gas controled? Is the valve easy to find? Look in the carburetor throat. Where does the gasoline come out?

Find the choke butterfly. Is it clear how it directs the flow of air over the choke jet?

How many holes are there for gas to come into the carburetor throat? Could one of them be for low speed and one for high speed? Does the carb have needle valves for adjusting the flow of gas to the jets? Is the high speed jet adjustable or is it a fixed jet?

Try to burn a dry stick with a match. Carve the same stick into shavings, and try to burn it. Why do the shavings burn faster? Does this explain why the carburetor tries to break the gasoline drops into smaller drops or vapor?

Icing in an airplane isn't easy to understand. If possible, get a pilot to explain it if it isn't clear. Compare a chainsaw carburetor with an outboard carburetor. What is the difference?

Student response to "Science of carburetors"

What is the job of a carburetor?

What makes the job of a carburetor difficult?

What happens to an engine if it gets too much gas?

What happens to an engine if it doesn't get enough gas?

What is the job of the air cleaner?

What would happen if there were no air cleaner?

What does the "jet" do?

Draw a picture of a carburetor throat, including the low pressure area that allows the gas to come up through the jet.

Draw a picture to show how the choke works.

The job of the jet in the carburetor is to allow gas into the throat but also to break the gasoline drops into small droplets. How does this help burning?

What are the main problems with carburetors?

Can these be blamed on the machine?

Describe, if you can (this is hard), how icing happens in a carburetor during the warmer months.

SCIENCE OF A CHAINSAW CLUTCH
Concepts:friction, centrifugal force

If the chain on a chainsaw was turning all of the time, even when it was idling, chainsaws would be very dangerous. There is a need for a clutch that will let the engine idle freely and yet will give a solid connection between the engine and clutch when cutting. The clutch also needs to be automatic, as all of our hands are being used in holding the saw.

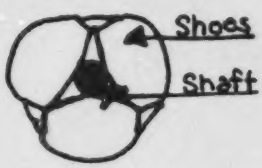
The clutch in our chainsaws does all of these things. How does it work?

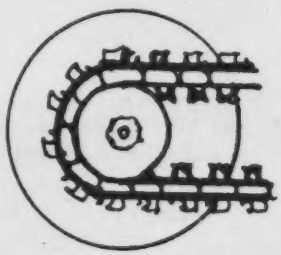
It is easy to picture a wooden airplane on a string. The faster it swings around our head in a circle, the more it wants to fly away from us. This is called "centrifugal force". We wouldn't use the word, except that the clutch in a chainsaw is a "centrifugal clutch".

The centrifugal clutch on the chainsaw is made of two main parts:

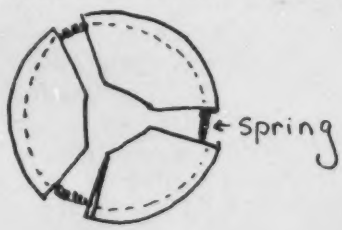
1)the drive shaft and shoes
2) the drum

The drive shaft is connected to the shoes. The drum drives the chain.



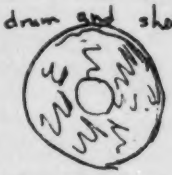


The shoes and drum are not connected unless the engine is spinning fast.
How does this work?



There is a spring around the shoes. When the engine is spinning slowly, the centrifugal force isn't strong, and the spring holds the shoes against the shaft. But as the engine spins faster, the centrifugal force increases until the shoes fly away from the shaft and rub against the drum. There is so much friction between the drum and the shoes that the drum spins with the shoes. The sprocket connects the chain to the drum and the chips fly.

Try that another way. When the engine is spinning slowly, the drive shaft and shoes are turning, but the drum, sprocket and chain are not moving.



When the engine is spinning fast, the drive shaft is spinning and so are the shoes. But the shoes fly out to the drum, which drives the sprocket and chain.

SCIENCE OF A CHAINSAW CLUTCH
Suggested activities

Take the cover off a chainsaw clutch. The chain and clutch drum should be obvious. With a wrench, take the clutch drum off. This means holding the shaft still. If this presents a problem, take the sparkplug off, get the piston on the bottom of its stroke by turning the magneto, and cram nylon rope into the cylinder until it is rather stuffed. Now the piston will hold the crankshaft from turning, and the nut holding the clutch drum can be removed. (Note: some older chainsaws have left handed threads on the clutch side.)

The shoes should be under the drum. The spring should also be obvious. Try to pull a shoe out. How strong is the spring?

Look inside the drum. Are there any places where the clutch is turned blue from the heat of friction?

To see the effect of centrifugal force, a weight can be attached to a string, and the string to a strong rubber band. Let a student hold the rubber band and swing the weight around his/her head. The centrifugal force should be plain as the rubber band stretches. The faster the weight is swung, the stronger the force is. This same thing can be done with different weights. Spin the weight slowly, then fast, then slowly again. This is the same as starting the chainsaw on idle, speeding it up and slowing it down again.

Can the students see the similarities with the chainsaw clutch and the weight on the string? What would happen if there was grease or oil inside the clutch drum?

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Student response to "Science of a chainsaw clutch"

What might happen if the chain and engine of a chainsaw were always connected?

What is centrifugal force?

What are the two main parts of the clutch?

What is around the shoes that keeps them from flying outward at low speeds of the engine?

If there were low friction between the shoes and the drum, would the chain stop under load?

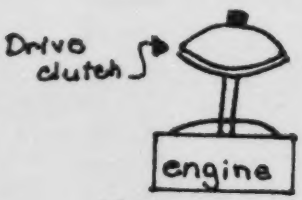
What happens to the shoes when the engine is slowed down after running at high speed?

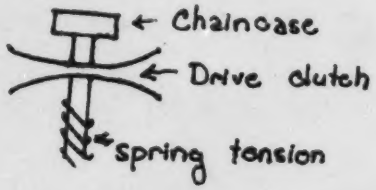
What do you think is happening when we run the chainsaw engine even though the chain is stuck and can't turn? Are the dogs slipping against the drum? Could this explain why the clutch drum turns blue?

Science of a snowmachine clutch

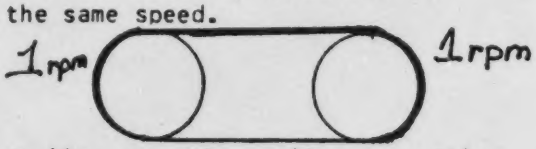
A chainsaw has a clutch that lets the engine spin at low rpm while the chain is not moving. When the engine is going fast, the chain turns with it. This is a fairly simple clutch to understand.The snowmachine clutch is a little harder to understand, but it does a fantastic job. The snowmachine clutch not only engages (connects) the engine to the chain and track, but it also adjusts the speed of the track so that the engine isn't screaming or struggling.

The part of the clutch that is connected to the engine is the "drive clutch", and the part that is connected to the chaincase is the "driven clutch". The drive clutch is where the action really is. The driven clutch can only respond to the drive clutch. Of course, the belt connects the two of them.



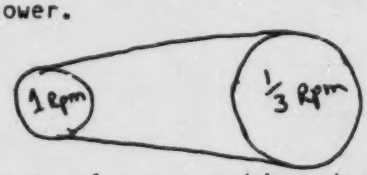


If two same size pulleys are connected by a belt as one turns, the other will turn at the same speed.



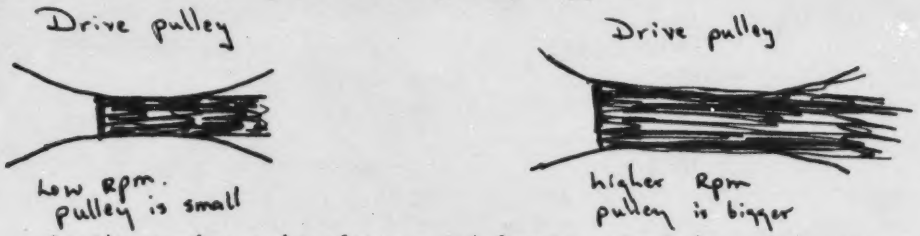
If a big pulley turns a smaller one, the smaller one will spin faster.

If a smaller one turns a bigger one, then the bigger one will spin slower.



The beauty of a snowmachine clutch is that it is made of two pulleys, whose size can be changed while it is moving! When the engine is idling, the sides of the pulley aren't touching the belt, and there is no connection between the drive and driven pulleys. When the engine is speeded up, the outside of the driven pulley moves towards the inside one. It soon contacts the belt, and the snowmachine starts moving. But the fantastic part comes when the outside half of the drive pulley keeps moving in towards the inside half. As it does this, the belt has to move towards the outside of the pulley. This has

the effect of making the drive pulley bigger.



As the engine spins faster and faster, the belt moves more and more to the outside of the drive clutch. As this is happening, the driven pulley is spreading apart, and the belt is moving in towards the middle of the pulley. This has the effect of - when the engine isn't spinning too fast, the drive pulley is "small" and the driven pulley is "big". This gives the engine lots of power to get the machine going faster. But once the engine gets going faster, the engine starts to speed up too fast. When this happens, the drive pulley gets "bigger" and the driven pulley gets "smaller", which has the track turning fast and the engine turning at a gas saving slower speed.

This is alot easier to understand while watching the clutch turning than itis while reading about it. A word of caution- clutches grab scarves, parts of bodies, and other valuable stuff. A machine shouldn't be run without a clutch guard!

So a snowmachine clutch does the same job as a transmission in a car or truck. But it shifts automatically and is constantly balancing the load with the engine.

This is a really good feature to have and would be used in cars and trucks if that much power could be transmitted by a belt. Unfortunately, truck and car engines would burn belts constantly, as there isn't enough friction between the belt and the pulleys.

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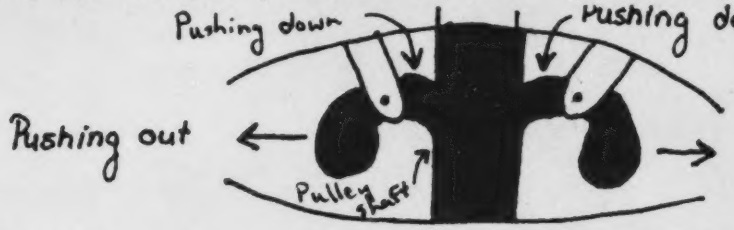
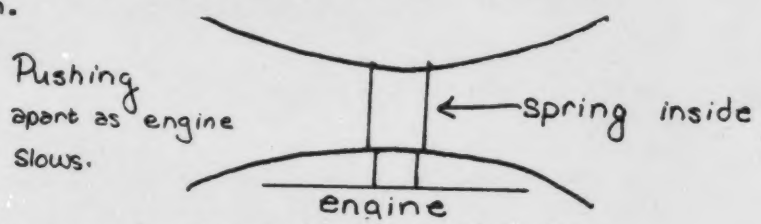
One thing that hasn't been discussed yet is how the outside half of the drive clutch moves in as the engine speeds up. Newer clutches have many different ways of doing this, but the idea behind them is all the same. There are dogs on the half of the pulley that fly out by centrifugal force. As they fly out, they push the pulley towards the other half of the pulley.

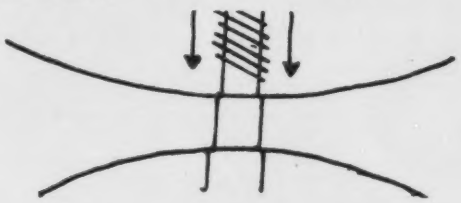


As the dogs fly outward by centrifiyal forced, they push on the end of the pulley shaft

There is a return spring that will push the pulley apart when the engine speed slows down.



The driven pulley also has a spring that pushes it together when the engine speed slows down.



It is pretty clear to see that good performance of the machine and a great savings in gas result from a properly working clutch. If the clutch is dirty or sticking, then it won't shift, and the balance between the engine and the load is thrown off. Either the engine will scream with too little a load or will groan with too much load.

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SCIENCE OF A SNOWMACHINE CLUTCH
Suggested activities

Remove the clutch guard from a snowmachine. Identify the drive pulley and the driven pulley.

Block the back of the machine up or hang it by a rope from something high so that the track can spin freely. Be sure that all people are far from the moving parts of the clutch and no one is in front of the machine in case it falls off of the blocks.

Start the engine, and change the speed.

Is it clear that at low rpm the drive clutch is small, and the driven clutch is large for great power on starting? Is it clear that as the engine rpm is increased the drive pulley gets bigger, and the driven pulley spreads to get smaller? At high rpm the drive pulley should be turning slower than the driven pulley. This is for cruising at high speeds with a minimum of gas used.

Is it clear that the clutch system acts like a transmission with no shifting from one gear to the next?

What would slip if the track was frozen down, and the engine was run? What would it be like if the clutch was sticking and didn't flow freely?

Stop the engine, and try to see the dogs in the drive pulley. If they can't be seen, try to get an old drive clutch. Try to understand how the dogs flying out by centrifugal force would push the pulley together. Is it clear that the snowmachine clutch is a masterpiece of simplicity and efficiency? The load is always balanced with the engine as long as the clutch is moving freely.

Student response to "Science of a snowmachine clutch"

Which clutch is connected to the engine?

Which clutch is connected to the chaincase?

Draw a picture of a big pulley turning a smaller one. Which is turning faster?

Draw a picture of a small pulley turning a bigger one. Which is turning faster?

Of the above pictures, which one shows how you would want pulleys to be for starting out with low speed and with high power?

Of the above pictures, which one shows how you would want pulleys to be for cruising at a high speed with the engine working slowly?

What is the advantage of a snowmachine clutch over a car or truck transmission?

Why can't a snowmachine style clutch be used on cars and trucks?

Draw a simple picture showing how a driven clutch will close as the engine speed increases?

What is happening to the driven clutch when the drive clutch is tightening?

True or false-the snowmachine clutch balances the load with the engine's power.

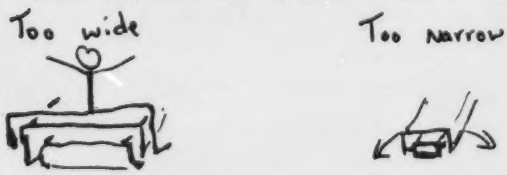
SCIENCE OF A SNOWMACHINE TRACK.
Concepts: surface area, friction

Snowmachines have been in villages long enough now that many children under 10 are curious about the dog teams that some people are using. A basic understanding of snowmachines is handy.

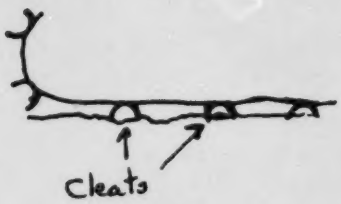
It wasn't until science and technology could come up with good material for a track that snowmachines had a chance of being practical. A book on the Klondike gold rush described a powered vehicle that the builder thought could travel over snow and all kinds of country. It had a large steel track with big teeth. It dug itself straight down and never moved one foot towards Klondike gold.

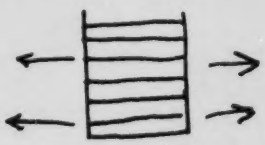
It is true that a track that is made out of real rubber wouldn't last long at all, as rubber is dissolved by gas and oil. Science came up with Neoprene and other materials that act like rubber but don't dissolve in oil or gasoline. But even these materials aren't good enough by themselves. They are firm enough to hold up the snowmachine without smashing or folding, and they are flexible enough to bend in very cold weather, but by themselves they can tear easily. Scientists had to develop a way to put strong nylon strings all through the man-made rubber materials. Nylon by itself would wear out quickly. Man-made rubbers can tear easily. Together they make a durable track. If the track is too thick, it would take a great deal of the engine's power just to turn it around, so the track must be as thin as possible and yet be able to stand a terrible beating.

The surface area of the track determines how well the track stays up on soft snow and how well it holds to a trail. If the track was very large, it would give a great lift to the machine on soft snow, but it would be hard to turn the big track. Try to turn one by hand sometime. Even a small one takes a lot of energy to turn. If the track was too small, the machine would sink deeply into the snow and wouldn't be able to hold the trail while pulling a load up a hill. It would spin out easily. If the track was too wide it would be hard for the driver to spread his legs around the body as he drove. If the track was too narrow, the machine would be tippy. If the track was too long, it would make the machine hard to turn, and if the track was too short, the machine would dip into all the rough places on the trail and give a jerky ride. Most snowmachine tracks have been made while realizing that different kinds of people will use them for all different kinds of uses.



The surface of the track is important. If a track was too smooth, it would spin out on a hill with a load. If a track was too rough, it would dig itself down into the powdery snow on a cross country trip. Some tracks have nothing but man-made rubber on them. These are better for breaking trail. They tend to stay on top of the snow and don't bury themselves too easily. Some tracks have steel cleats all the way across. These tracks will seldom spin out on a hard packed trail. They can pull loads up hills when smooth tracks can't. Cleats increase the friction of the track as it tries to go forward but don't keep the track from slipping sideways on clear ice.





There is no perfect track, because one track is better for one purpose, and another track is better for another.

The main things to consider are the surface area of the track and the surface of the track. What will you use the machine for mostly? Choose a track that will best suit you.

SCIENCE OF A SNOWMACHINE TRACK
Suggested activities

Put gasoline on a rubber band. What happens? Does this explain why tracks aren't made of real rubber?

Look at the different snowmachine tracks in the village, and look at some broken tracks. What might be the cause of the broken tracks? Would adding more nylon fibers help? What would a track be like if there were no nylon?

Try turning a track by hand. Is it clear why tracks are made as thin as possible?

Bring a drive belt (which is the same material as a track) inside, and test it for how stiff it is, and then bring it outside, letting it cool. Put it in the freezer if it is too warm outside. Test it for how stiff it is. Is it clear how much energy it takes to turn the track around, especially when it is cold? Compare different tracks, cleated tracks, smooth tracks. What do people say is good and bad about each? Were they made for different purposes? Consider width, thickness, and surface of the track.

Student response to "Science of a snowmachine track"

Why wouldn't a track made out of real rubber last?

Why wouldn't a track made out of nothing but man-made rubber last?

What is added to man-made rubbers to make a good track that can stand the rough use a track gets?

What is the problem with a very large track?

What is the problem with a very small track?

What is the problem with a track that is too smooth?

What is the problem with a track that is too rough?

What kind of a track would you want for breaking trail in powdery snow, and why?

What kind of a track would you want for racing or pulling a load on a hard trail?

SCIENCE OF A GASLAMP
Concepts: surface area

Every Alaskan has seen a gaslamp, and many of us have had nothing but gaslamps for light. They were designed so well long ago that there are no major improvements made on them.

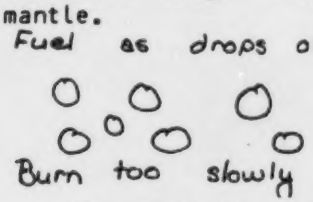
There are three main parts on the gaslamp;

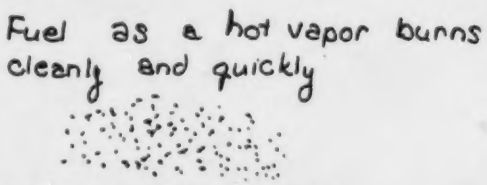
1) the tank
2) the generator and
3) the mantle

All of the other parts hold these three things together.

The tank is made to hold fuel under pressure. The pump is designed to make pressure. The generator is where the fuel is heated from a liquid (like water) to a vapor (like steam). The mantle is where the fuel and air burn to make heat.

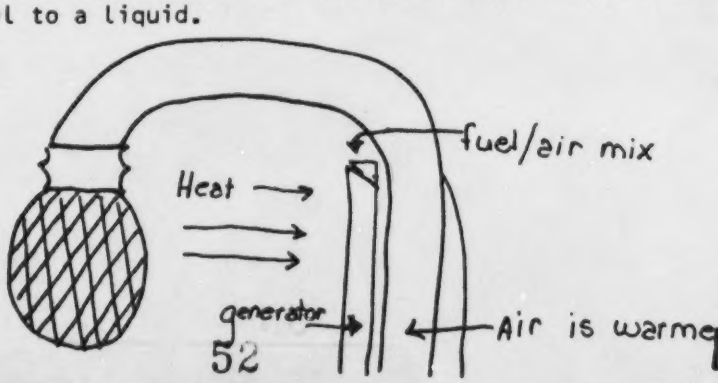
The generator is a special part. If the fuel got to the mantle as a liquid, the fuel drops wouldn't burn well. Which burns faster, shavings or sticks of wood? Obviously the shavings burn faster because they have a greater surface area to burn on. The fuel is heated to a vapor in the generator. In the form of a vapor, it has a very high surface area. It can mix well with air and can burn fast and clean. When we first light a lamp, it burns poorly with a yellow flame until it warms up. It is burning as a liquid. The warm up time is the time required to heat the generator to the point that the fuel will boil to a vapor. If you light a lamp that has just been turned out, there is no warm up time. Why? The generator is still hot. This also explains why an uncovered lamp will flame out in cold weather. The generator cools off to the point that it can't heat the fuel to boiling. The fuel gets to the mantle as a liquid and doesn't burn fast enough. The fuel is still burning after it passes the mantle.





The generator has a tiny hole that allows a measured amount of fuel. If the hole gets plugged, then fuel can't pass. If the hole was too big, then too much fuel would come out. The lamp would flame up and would use too much fuel.

Behind the generator the air intake is also heated so that the air is hot when it mixes with the fuel vapor. Cold air would cool the fuel to a liquid.



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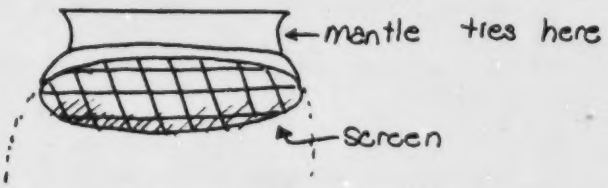
Above the mantle there is a screen. The screen does two jobs:
1)it mixes the fuel and air better so that burning is complete, and
2)it stays hot to keep the flame burning
Without the screen, the flame can cool rapidly and burn inefficiently. With the screen, burning temperatures are kept. The burn is steady.



It is beyond the level of this explanation to describe how the mantle glows with heat. You can look forward to high school physics to find out why.

Understanding the gaslamp will help anyone fix the lamp. If the generator isn't working well, then dirt inside is probably insulating the fuel from the heat. Clean the dirt out, and the fuel can heat properly. If the screen is burned out, it is clear why the flame is not steady, and why the flame is not efficient.

SCIENCE OF AN ALADDIN LAMP
Suggested activities
Examine the wick of an Aladdin lamp. Is it cotton or nylon? Without the mantle on, scrape the wick so that it is not even. Does it burn high on one side? Trim the wick with the wick trimmer. Try to burn it now. Does the wick burn with a good strong flame, or is it a lazy yellow with soot? Why is this?

Put the chimney on while it is burning. Does this explain anything? Gently put the mantle over the burning wick, and tip it from side to side. Does it glow unevenly? Take the "thimble" out of the center of the wick after blowing it off and letting it cool. How does it burn now? Put the whole lamp together properly, and get it burning well. Adjust the wick so that the mantle is glowing nicely. Cover the holes on the bottom of the lamp with your hands. Why does this change the flame? Put a metal cap carefully over the chimney. How does this change the flame?
If you can find a piece of metal pipe that is about the diameter of the top of the chimney, use it as an extension of the chimney. Does this increase or deacrease the flame. Why?
A WORD OF CAUTION. ALADDIN MANTLES AND CHIMNEYS ARE FRAGILE AND AREN'T CHEAP.

Student response to "Science of a gaslamp"

What are the three main parts to a gaslamp?

What is the main job of the generator?

What happens to the fuel in the generator?

Why does the fuel as a vapor burn better than as a liquid. Draw a picture if you like.

Why do you think that the generator passes over the burning mantle?

The screen does two jobs. What are they?

If the lamp isn't burning well, and the flame often comes out a yellow flash, what do you think is wrong with the lamp?

SCIENCE OF A WOOD STOVE
Concepts: surface area

We don't pay much attention to our wood stoves until they run out of wood or fill our houses with smoke. Most of us have been looking at the same kind of stove for a long, long time. We don't really give them much thought unless we are tired of getting wood, and then our thoughts about the stove are ugly. But there are things to learn about wood stoves that will help us understand lots about the world around us. What we can learn from wood stoves can be used over and over again in other studies. The first part of understanding a wood stove is understanding the wood.

There are three things that go together to make wood (along with some minerals):

1)water
2)carbon dioxide
3)energy from the sun

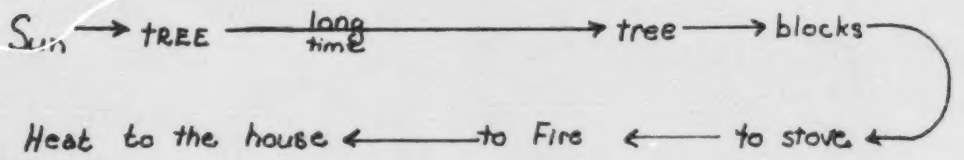
The water mostly comes from the ground , the carbon dioxide comes from the air, and the sun, luckily enough, is always around summertime. The process of putting water and carbon dioxide together with the energy from the sun takes place in the leaves of the trees.

Now, here's the magic question- how do we get the energy back out of the wood?

TREE Growing
Water + Carbon Dioxide + Suns Engery + minerals → WOOD
TREE BURNING
WOOD → Water + Carbon Dioxide + waste gasses + Energy + minerals (ASH)
SMOKE

We can pound the wood, and the energy won't come out. We can shake it, squeeze it, yell at it and threaten it, and the energy won't come out. Since you were old enough to get up in the morning, you knew that it takes a little bit of heat from a match to get the process going of releasing the heat from the wood.

In years past the heat from the sun was stored in that wood, and as it is burned in the stove the heat from 20-30-80 years is let off in a short time.....4-5 hours. Follow the diagram below.



It takes three things to have fire:

1)something to burn (fuel)
2) heat
3) air -or oxygen to be exact.

If we want to speed up burning we can increase any one or all three of these things. Adding wood to a fire makes it burn faster because there is more wood to burn, but also because the sticks of wood burning are heating each other up too.
Three kids in a bed are warmer than two.
Three sticks of wood in a fire are warmer than two. By increasing the amount of air, we can make a fire burn faster. If there isn't enough air the fire will burn slowly.

In a wood stove we have all three things needed for a fire

1)wood
2) heat
3) air

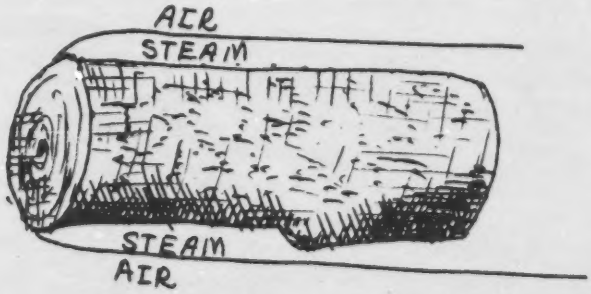
Our fire will increase if we add wood, add heat (by adding wood) or add air(open the draft). The mud we put in the bottom of the stove keeps the temperature of the fire more even. Without mud, the fire would not burn with an even heat. It would get too hot and too cold. The mud evens the temperature.

There are problems with burning wood. When we burn oil in a stove we control the amount of fuel. But when we burn wood, we can't let the wood "leak" into the firebox. We can't control the flow of wood. We have to try to control the amount of air that gets to the fire. This works fairly well in an airtight stove, but often stoves will go out of control. They blast the house with heat and then leave it cold when the wood is gone. Many gasses are driven from the wood that could burn if there were enough air. However, they go up the stovepipe because they didn't have enough air to burn them.

As the air goes into the stove, there is efficient burning going on. The wood is there, the heat is there, and the air is there. But towards the back of the fire, there is much waste. The wood is there, the heat is there, but the air that gets to the back of the fire has most of the oxygen already burned from it. When we burn green wood there are two disadvantages.

1) We must boil the water out of the wood to get it to the burning temperature. This takes heat that could go to heating the house.Just as bad as this is

2)The water given off as steam from the wood keeps the air from getting to the fire. A cloud of steam separates the wood from the air. This suggests, then, that long wood in a stove isn't very efficient as the back of the stove isn't a healthy place for fire.



It is plain to see that burning drywood is better than burning greenwood. Greenwood has the same amount of heat energy in it as drywood does, but there is a great wasting of that energy. It is plain to see that burning wood would be more efficient if we could put the wood, air and heat together in just the right amounts. But we must be satisfied with controling the wood fire by controling the air supply.

Water, carbon dioxide and the sun's energy from before you were born went together with minerals to make wood. We cut down and haul the trees. We stack them and burn them. For a few hours our house is warmed by the energy that one tree took years to store up. How lucky we are that there are enough trees. How lucky we would be if we could think of a better way to burn wood to get all of the energy out of the fire and into our houses.

This is also the time to mention something else. Most wood stoves have no moving parts except the doors. How does the air keep flowing past the fire? It is lucky for us that warm or hot air rises. The fire itself causes the air to heat up. As warm air is lighter than cold air, cold air flows in the bottom of the stove, pushing the warm air up the stovepipe. If this wasn't true, we would have to somehow pump air into our stoves.

Stoves are fun to think about and work on, as we can always wish for and
design another stove that will give us more heat while burning less wood.

SCIENCE OF A WOOD STOVE
Suggested activities

Hold a very cold piece of iron over a small flame. Can you get the water in the the smoke to condense?

Call attention to the controls of a wood stove, the damper on the stovepipe, and the draft regulator somehwere around the door. Adjust these with good drywood inside. The response to the controls should be immediate.

Put a very green stick of wood on the fire, and let it heat up for a while. Open the stove door, and observe the steam hissing out of the wood as it screens the air from the wood.

Discuss the difference between hauling heavy greenwood, and lighter drywood, and the trouble involved in getting either.

Encourage the students to get information on all of the new style wood stoves, and discuss the advantages of pre-heated air, secondary air, air-tight construction etc.

Student response to "Science of a wood stove"

What three things go together to make wood?(This doesn't include minerals.)

Where does this happen in a tree?

What three things does it take to make a fire?

What happens if a fire doesn't get enough air?

What happens if a fire gets too much air?

What job does the mud in the bottom of the stove do?

In an oil stove, we control the amount of oil flowing into the firepot, but in a wood stove we can only control the amount of what?

What are the disadvantages of burning green wood?

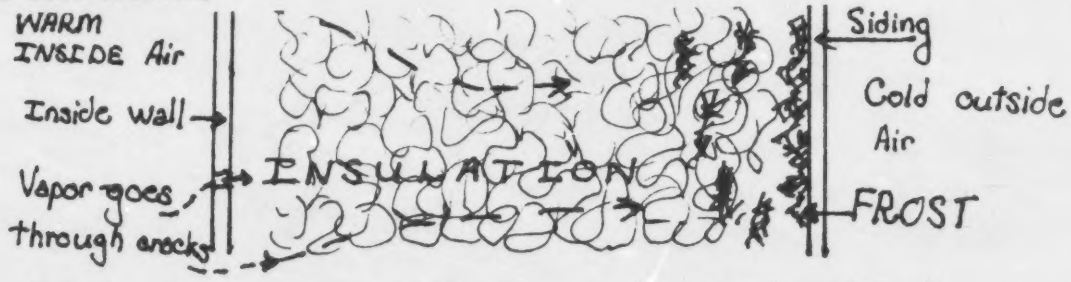
Often we grumble about getting wood. What would you do if you lived on the coast, and there was a real shortage of oil so that you couldn't get any?

Science of a vapor barrier in a house

A house can be saved or quickly destroyed by the right or wrong use of a vapor barrier (clear plastic). As long as house materials are dry, bacteria and other forms of rot cannot live. A house could last for a very long time if it were kept dry and free from rot.

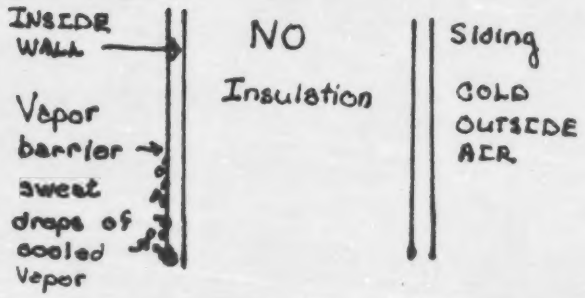
Vapor is water in the air. We can't often see it unless it is really cold, and we can see it as frost in our breath. If there were no vapor, then our lungs and noses would be very dry all of the time. But vapor can also be the water that bacteria need to live and rot things too. What we need is a house where there is vapor in the air for our lungs and noses, but where the vapor can't get to the materials that the house is made of. In this modern age we are lucky to have sheets of plastic. When it is used to keep vapor in or out of somewhere it is called a vapor barrier.

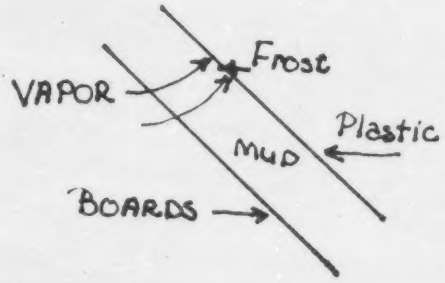
If a house has no vapor barrier, it would look like this across a wall section.



The vapor in the warm air of the house would enter the wall and insulation. As it got closer to the outside wall it would cool off. Cold air can't hold as much vapor as warm air can. (This is why vapor falls out of your warm breath when it is cooled in wintertime.) The vapor would turn into water drops or even frost within the wall. When the weather got warm again, the frost would turn to water and the house would start to rot.

If a house had a vapor barrier, but had no insulation, then the warm air of the house would cool off as it hit the cold vapor barrier. Water drops or "sweating" could form, and run down the inside wall of the house, or turn to frost if it was really cold. Isn't this what happens to windows in wintertime? They are a vapor barrier without insulation.





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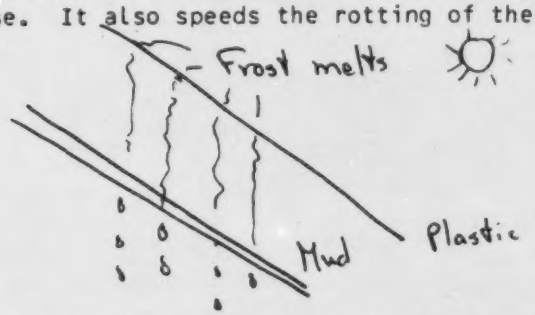
The ideal situation then, is a wall or ceiling with a good vapor barrier BETWEEN the ROOM and the INSULATION. A vapor barrier without insulation will frost or sweat. Insulation without a vapor barrier will sooner or later be filled with water from vapor that got cooled off.

Some people have tried to cover log house roofs with plastic over the mud. Certainly the mud is acting as insulation, but the vapor barrier is on the outside. When it is cold, the vapor travels through the mud, and gets cooled off on the inside of the plastic, and turns to frost. When it warms up, the people's breath(vapor) turns from frost to water, and drips back into the house. It also speeds the rotting of the roof boards.



Sheets of plastic are wonderful to have, and they work to protect the walls and parts of a house from the damp vapor that could cause them to rot.....but plastic only does this if it is put on with understanding.

SCIENCE OF A VAPOR BARRIER IN A HOUSE

Suggested activities

Check some of the houses in the village- some older ones, some log cabins, and some newer ones. Find out whether they have a vapor barrier or not.

Do any of them have frost problems or dripping problems? Are any of them rotting for reasons of no vapor barrier or wrongly installed vapor barrier?

Talk about windows that are single, double and triple. What is the difference in their frosting wintertime? Do students think that a house made from triple layers of plastic would be warm and frost free?

Student response to "Science of a vapor barrier"

What is vapor?

What would happen if there were no vapor in the air of our houses?

What happens when the vapor gets into the walls of our houses?

Is it warm air or cold air that can hold more vapor?

What happens to the vapor in warm air when it is cooled?

What happens when a house has a vapor barrier and no insulation?

Draw the cross section of a wall that is build right, with insulation and vapor barrier. Mark which side of the wall is outside and which is inside.

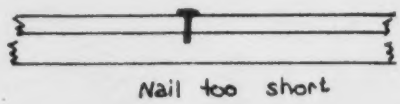
What is wrong with covering the roof of a log house with mud, with plastic over the top.

If you tried to explain the use of a vapor barrier simply to someone who didn't know, what simple rules woud you give them?

SCIENCE OF NAILS
Concepts- friction

There are many nails around the house and throughout the village. We tend to think of them as being big and little and nothing more. We often dump them all into a can, mixing them up as if there were no difference between them at all. This is okay, but really, nails are different for reasons, and different nails are made for different jobs.

The length of a nail certainly makes a difference. If a nail is too long, it will go through both pieces of wood, and will need to be bent over. If a nail is too short, it will not reach far enough into the second piece of wood, and it will pull out as soon as pressure is put on it. This much most people understand about nails.



The length of nails is expressed in "penny". Two penny nails are smaller than eight penny. No one really knows where the "penny" came from. Penny is often written "D" or "d". Nails are in the following sizes:
2d,4d,6d,8d,10d,16d,20d,30d,40d,60d,80d, 100d. The bigger ones are often called spikes, and are also measured in inches: "eight inch spike".

The thickness of a nail makes a differnce. If a nail is too thick, then it will split the wood that it is in. Everyone has had this happen even if they have driven only a few nails. If a nail is too thin, then it won't be strong enough to stand the pressure and will shear off.

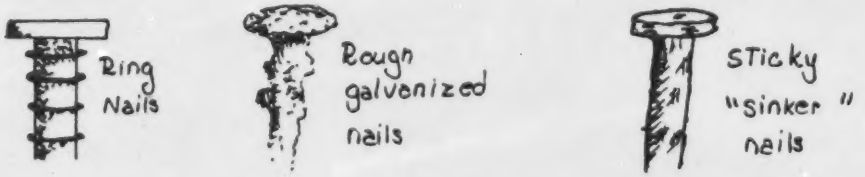
Most good carpenters say that many smaller nails are stronger on a joint than a few big ones. BOX nails are thinner nails and are often used with the lumber we get from outside. "Outside" lumber is kiln dried and is pretty easy to split. The only trouble with using thinner box nails is that outside kiln dried lumber is also very hard. Box nails will often bend on this lumber, even when a good carpenter is driving them. COMMON nails are thicker, stronger and are used on lumber native to Alaska. Common nails will often split "outside" lumber.

The heads of nails are different for different reasons. Box and common nails have heads just right for most lumber.Paneling nails would look funny if they had heads the same size as box and common nails. Paneling nails have smaller heads and are colored

so that they won't show on the paneling. Finishing nails have very small heads for use on finish work. Cabinets and fine furniture would look funny if they had big, shiny nail heads showing. Roofing nails are made with much bigger heads than any of these. It would be impossible to hold down tar paper with the small heads of finishing nails or common nails. Nails used on aluminum roofing are different too. These nails have a wide head to hold the aluminum from tearing in the wind. There is also a rubber-like washer under the head to keep water from leaking in around the nail hole. Perhaps you have seen nails with two heads. These are scaffold nails. They are used on things that must be put up for a while and then torn down again, like concrete forms or a scaffold used to work in or around a building. The lower head holds the wood tightly, and the upper head makes it easy to pull the nail out when the concrete has set or when the scaffold is no longer needed.

So we see that some nails have small heads to keep them from being seen, and other nails have bigger heads to allow them to hold and not pull through the material.

The long slim part of a nail is called the shank. The shank of a nail can be smooth to allow the nail to be driven and pulled easily. These nails are also cheaper to make. Some nails have a rough shank like aluminum roofing nails. The rougher the shank of the nail is, the more friction it has against being pulled out. Roofing nails must hold in strong winds. Sheet rock nails have rings on them to hold the heavy sheet rock on ceilings. Boat nails that have to stand constant twisting and pulling often have rings on them too. Some nails are coated with rough galvanize. This galvanize does two jobs. First it keeps the nail from rusting, and second the rough shank makes is hard to pull out. Many construction jobs use galvanize nails just for their holding power although they are quite a bit more expensive.Some nails have a sticky coating on them and are called "sinker" nails. These are often used in framing a building or rough construction. They are a bit more expensive, but hold the wood better than smooth nails.



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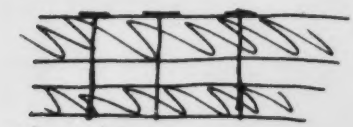
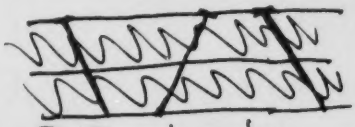
The way we drive nails in makes a difference in how they hold too. Nails driven into the end grain of wood don't hold as well as nails driven across the grain. If all of the nails are driven straight down, they can pull straight out. If they are driven in at different angles, then they don't pull out easily.

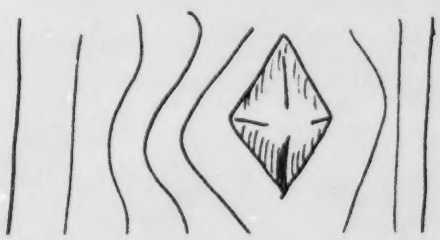


Straight in
straight out



Different angles
can't pull out straight

Have you ever had to drive nails close to the end of a board, and worried about the board splitting? Everyone has.
If you look at the end of a nail, especially a bigger one, you will see that the point is wide in one direction and slim in the other direction. When you drive the nail, let the nail go into the grain lengthways.



Hopefully you can now look at a can of nails, see the difference in them, and appreciate that difference.

SCIENCE OF NAILS
Suggested activities

Try to nail together two boards with a nail that is too short. How easily does it come apart? Try to nail together the same two boards with a nail that is too long. What is wrong here?

Identify box nails and common nails. Get a piece of scrap paneling or A-C plywood, a piece of tar paper, a piece of finished wood, and a piece of rough lumber. Drive all of the different kinds of nails into each. Discuss the advantages and disadvantages of each type of nail head.

Drive nails of each kind of shank into a piece of lumber, but with the head sticking up a little. Try pulling each kind of nail. Which is easier to pull out?

Drive a few nails into the end grain of the wood. Do nails hold as well in the end grain?

Fasten two boards together with three nails. The first time drive the nails straight in, then pull the boards apart. The second time, drive the nails in at an angle to each other, and again pull the boards apart. Which is easier?

Look at the end of a nail 20d or larger. Is it visable that one way the nail is narrower, and the other way it is wider?

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Student response to "Science of nails"

What is wrong if a nail is too long?

What is wrong if a nail is too short?

When we talk about the length of nails, we say a nail is 4 or 8___ .

What will happen if a nail that is too thick is driven into a board?

What is wrong with a nail that is too thin?

What kind of nails are thinnner and are used on outside lumber?

What kind of nails are thicker and are used on Alaskan native lumber?

Name the kinds of nails and tell why each has a different size head.

Nails are different for different reasons. Name the different shanks on nails and give their purpose.

If nails are driven straight into wood, they can pull straight out. Draw how nails could be driven to give more holding power.

Draw the point of a nail, and show how you would drive it if it was close to the end of a board. Do on the back.

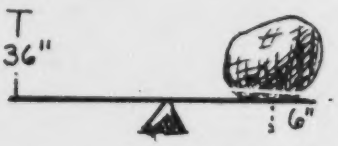
SCIENCE OF HANDTOOLS

While hand tools aren't complicated, we need to know how to use them in order to make the most of our effort.

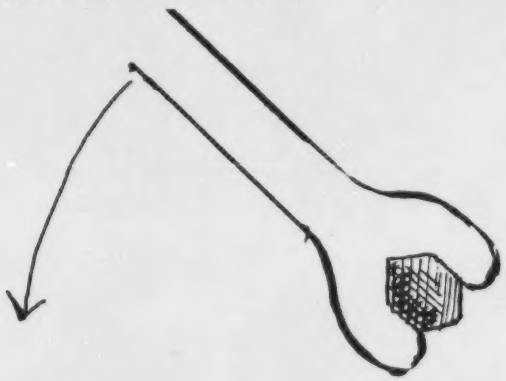
Leverage is what we are usually after with most hand tools. Everyone has tried to lift something too heavy, and has had to use a lever to lift.

Even to get a baking powder lid off we need to use leverage.

The advantage of a lever is that we can put great force against something. This might look like we are getting something for nothing, but we are not. Look at a lever lifting a large rock. While a weak person could lift the heavy rock, the weak person has to move a great distance to move the rock a short distance.



With a wrench, the nut turns a short distance, and the mechanic's hand moves a longer distance. The result is that the mechanic, through the wrench, put a great force on the nut, but had to move farther than the nut did.



Pliers work the same as a wrench, but the users have to put two forces on the tool. They must turn the nut, but must also squeeze the handles with leverage. Vise-grip pliers are good

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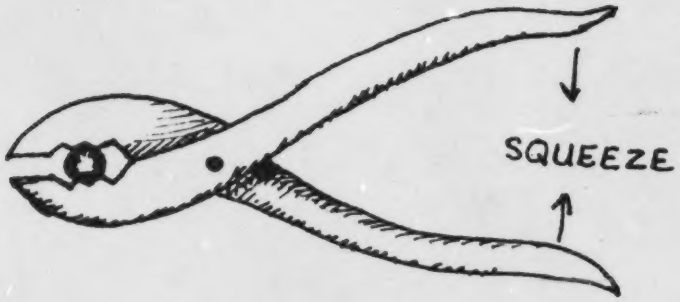
because they lock "squeezed".

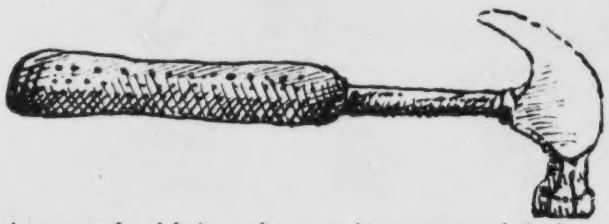


A screwdriver also uses leverage, but not much. If we twist the handle with pliers we can put more force on the screw.

A hammer is better than our hand for two reasons:

1)the most obvious is that it is harder than our hand, and

2)the hammer is heavier than our hand and is moving faster than our hand. As our hand is moving in an arc of 1 foot, the hammer is moving in an arc of over 2 feet.



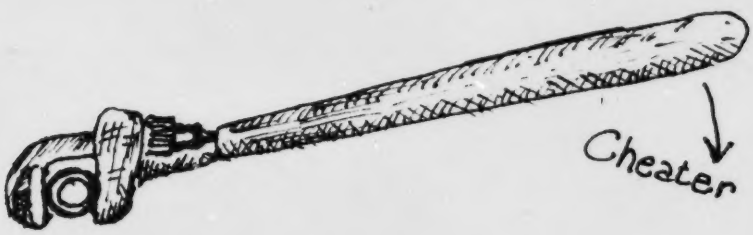
If the hammer is light, it can be swung with less effort. If it is too light, it can't drive the nails. If the hammer was too heavy it could drive a nail with one big thud, but the user would get very tired very fast. The size of the hammer should match the job. The force that something hits with depends on two things:

1)its weight

2)its speed

A hammer might be about the same weight as our hand, but certainly it is going faster than our hand. The longer the handle is on the hammer, the faster we can get it going. This is why holding a hammer close to the head is easier to swing, but holding it on the end of the handle is more powerful.

Anyone who has worked with old pipes has used a "cheater" at one time or another. A cheater is a pipe over the handle of a wrench that makes the handle longer. With a cheater, something has to give- either the pipe will come apart, or the wrench will break. There is tremendous power in the leverage of a cheater. The user moves a great distance with a small amount of power, while the pipe moves a small distance with a great amount of power.



SCIENCE OF HANDTOOLS

Suggested activities

Students could try to lift something with their hands and then with a lever. Look around the village for levers- there are lots like the lever on a 30-30, or the handle of an outboard.

Students could try to turn a nut by hand, and then turn it with a wrench.

The locking feature of vise grips could be explored and discussed (It's like our knees locking when we stand at attention).

If there is a wing nut around, students could try to turn it and compare it with a hex head nut.

Students could use a cheater on an open-end wrench even though a nut isn't really stuck. The difference between a wrench with and without a cheater could be discussed. The chance of stripping bolts and nuts on machinery should be discussed. With a cheater it is possible to break a bolt.

Students could try turning a screw with a screw driver, and then try turning it with a wrench on the handle. Is it easier?

Students could try pounding nails with the hammer held close to the head, and then farther and farther down the handle. Try driving nails with a big hammer, and with a very small hammer. Discuss the difference in the effort to drive a nail. Which would students want to use all day?

Student response to "Science of hand tools"

Draw a picture of the best way to lift something heavy if you aren't strong enough.

When we turn a nut with a wrench, which moves farther, the handle or the nut?

On which end of the wrench is the force the greatest, the handle end or the nut end?

Draw a picture of how you could get more leverage with a screwdriver.

Describe a "cheater" and draw a picture of one working.

SCIENCE OF SHARPENING TOOLS

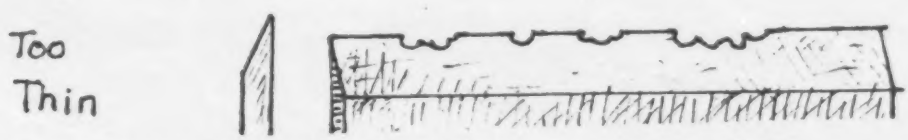
Concepts- friction

Often we treat sharpening like it was a mystery that only old people and saw shops in Anchorage know about. Sharpening is actually very easy to understand, and only the practice takes time.

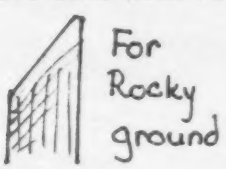
Anyone who is even a little lazy at heart should be interested in sharpening, as sharp tools can make a very hard job very, very easy. Have you ever heard the expression "dull as a hoe". Well, even a sharp hoe is better than a dull one.

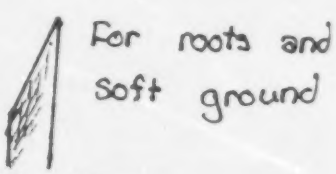
It would be impossible for us to cut down a tree with another piece of wood. Obviously, the wood is too soft. On the other hand, we could get an axe made that would be super-hard. This would be great until we needed to sharpen it, and then it would take a terribly long time, if we could do it at all. A cutting edge needs to be harder than the material being cut, and yet soft enough to sharpen with a file or stone. A cutting edge needs to be thin enough to go into whatever it is cutting, but thick enough so that it won't break and chip.

If an edge is too thin, then it will chip, crack, smash or fold over.

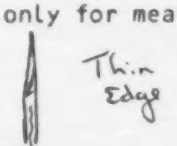


How thin do we make a cutting edge? There is no answer for this until we know what it is we are cutting. A hoe that we use in a rocky garden will have to have a thicker edge than one used in soft soil with roots to be chopped.

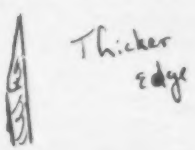




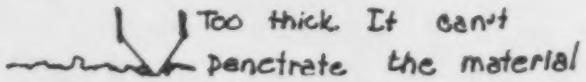
A knife used only for meat can have a nice thin edge.



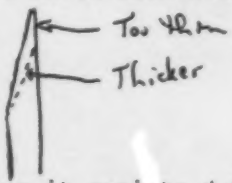
A knife used for meat and bone will have to have more steel behind the edge to keep it from chipping on the bones.



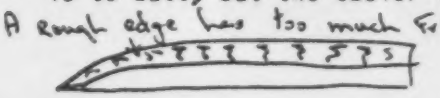
An axe used on clean greenwood can have a thinner edge than one used on dirty wood or drywood. This sounds awful fussy, but it is pretty easy to get the idea. If an edge is really pointed, and yet the blade has trouble penetrating, then the blade needs to be thinned.



If a blade has chips and nicks in it soon after sharpening, then it needs to be thickened.



The harder a knife is, the more it resists dulling, but the harder it is to sharpen. The softer a knife is, the easier it is to dull, but the easier it is to sharpen.



If the sides of a cutting edge are rough, there will be too much friction while cutting. Smooth sides allow the edge to slip into the cut smoothly.

Dull tools are not only hard work, but they are dangerous. We have to put so much more pressure on dull tools than we do on sharp ones. They slip with great force. A properly handled sharp knife is always in control.

SCIENCE OF SHARPENING TOOLS

Suggested activities

With a piece of soft wood, like cottonwood, try carving with a dull knife. The result is obvious. Sharpen the knife. Try again.

Try chiseling the wood with a cold chisel. Why doesn't it chisel? Split a stick and put a razor blade in the split. Tie it tightly as you might a stone-age style axe. Carefully try carving with the razor blade keeping hands well away from the blade. What happens? What can you say about thick and thin blades? Try sharpening a blade in different ways, thick and thin. Compare the edges on a hand plane, a draw knife, a wood carving knife, a razor blade, a garden hoe or shovel, and a cold chisel. Can anything be said about the thickness of the edge and the material each tool is made to cut?

Student response to "sharpening tools"

Could a wooden axe chop a tree? Why?

What will happen if a cutting edge is too thick?

What will happen if a cutting edge is too thin?

Can anyone tell you how thick or thin the edge on your tool needs to be if they don't know what you will be cutting? Why?

If you had to work on something that dulled your knife often, would you want harder or softer steel in your knife?

Why should the finished edge on a tool have smooth sides?

SCIENCE OF GOLDPANNING

Most Alaskans have either panned a little or heard stories of old timers panning gold. If we get wood in a sloppy way, it doesn't hurt too much. But if we pan gold in a sloppy way, we can lose a great deal in a very short time.

In order to pan gold, we first need a place where there is gold or where there might be gold. If we are good at panning, we can soon tell if there is a chance for gold in a creek or not. But if we are poor at panning, we don't know:

1)if there is no gold or if
2)our panning is bad

There are two things to remember about gold.

1)it is expensive
2)it is heavy

Number 1 is why anyone wants to pan gold. Number 2 is what people use to separate gold from the material it is mixed with. There are many places in Alaska where there is gold. The only trouble is that there are many other minerals and rocks mixed with a small amount of gold. It is not worth mining where it costs $150 to get $20 worth of gold. There has to be a good way to separate the gold from the other materials. Gold is so much heavier than most other material that we can use its weight to help us.

Everyone knows that heavy things sink and that light things float. The word DENSITY will help us here. Which is heavier, a boat or a spoon? Clearly a boat is heavier, but it floats and the spoon sinks. Before we talk about this any farther we need to realize that weight isn't the only thing to think about. We have to think about how much space something takes up as well as its weight.

If something has high weight and doesn't take up much space, we say it has high density (it will sink in water). If something is heavy, but takes up lots of space (like a boat), it has low density (it will float on water).

If something is light, like a small bolt, and takes up very little space, then it can have high density too. It isn't only how heavy something is that makes a difference. How much room it takes up makes lots of difference too. You can shape tin-foil into a boat and it will float. You can smash the same piece of tinfoil into a tight ball, and it will sink. Did the weight change? No. But the space that it takes up is changed from large to small.

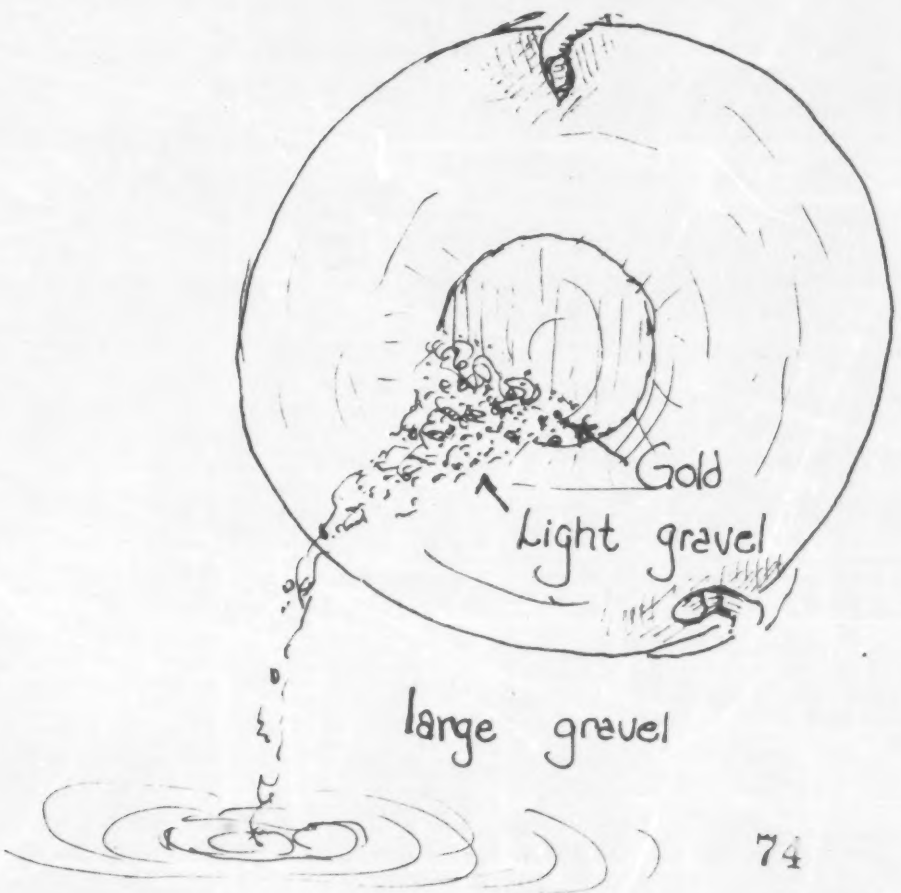
Gold has a very high density and a low surface area. It has much weight for the space that it takes up. If you had a bar of gold the size of a bag of popcorn, you probably couldn't lift it

up.

As we have a mixture of small gravel in a gold pan, the gold is scattered somewhere throughout the pan. If we put water in the pan and start swirling the mixture of gravel, gold, and water something happens. The gravel has a lower density than the gold. It is caught up by the water and carried over the side of the pan. Little by little we can add more water and swirl the material in the pan, remembering that the gold has a greater density and less surface area to get caught up by the water. We can be confident that the worthless gravel and sand are being carried over the side of the pan as long as we have given the gold enough of a chance to work its way to the bottom. The exciting part is when there is nothing left but black sand in the pan and a great hope in our heart. The density of black sand and gold are close to the same, so the panner has to be careful at the end, sloshing the black sand away, and keeping the gold . We shake the pot while making popcorn for the exact same reasons. The high density seeds settle to the bottom to pop, while the low density popped corn is pushed to the top away from the heat.

If we have panned well, we know if there is gold or not. If we pan sloppily, then we can never be sure if there was gold or not. As we are looking for gold, we can be fairly sure that gold's high density will keep it in the lowest places possible. Creeks and valleys have a greater chance of having gold than other higher places.

The density of gold is so great that we can be sure that where there is gold and motion, the gold will be settling to the bottom.



SCIENCE OF GOLD PANNING
Suggested activities

If there is a shortage of goldpans, frying pans or even pie pans will work for practice. As gold is too expensive to practice with, use the shot from shotgun shells. Lead is also high density.

Students could see if they could get as many lead shots in the bottom of their pans as were put in there. The smaller shots- #6 will be harder than the #2 shot.

The concepts of density and surface area could be constantly related to the activity. This could be done in a tub wintertime, with gravel from someone's unfrozen basement or from a water hole in a gravel bottomed creek. Fine gravel is best.

Student response to "Science of gold panning"

What are the two things to remember about gold?

Which has more density, a spoon or a boat?

What must we think about besides weight when we talk about density?

Does gold have high or low density?

Do you think that the density of a bag of popcorn is greater or less than the density of water?

Does gravel have a density greater or less than gold?

Is there much difference between the density of gold and black sand?

You know that the density of gold is high, and that many forces have been at work on the earth for a long time. You know that gold has been slowly shifting and moving for thousnads of years. Where would yo start looking for gold around your village?

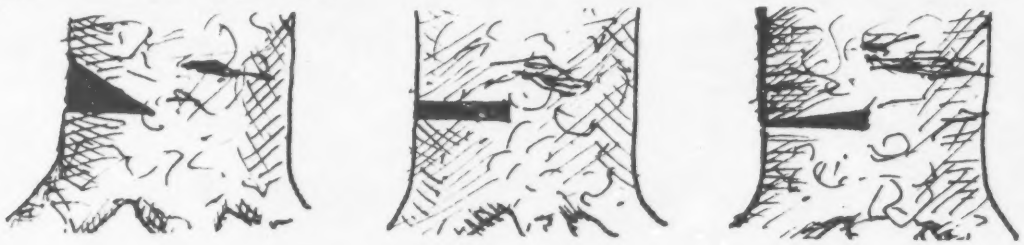
SCIENCE OF CUTTING DOWN TREES
Concepts- surface area, center of gravity

It takes more than effort to knock trees. Knocking trees is easy enough, but to do so accurately and safely takes a little bit of know-how.

Before we knock a tree we try to determine which way it is leaning. If the center of gravity of a tree is more to one side than another, it will fall that way.

If a tree is fairly straight, with the center of gravity right over the stump, then it might take some outside help to make it start leaning. A tree with lots of branches has a great surface area for the wind to catch and push against. On a very windy day a tree that is leaning one way can be pushed backwards by the wind if there is enough surface area for the wind to act on.

Once the logger decides which way the tree will go, the logger needs to notch the tree on that side. The notch should be a wide V or the tree will lean until the cut is closed, and then hang up. This is dangerous.



If a tree isn't notched at all, it can split up the trunk for quite a ways, and be very dangerous. A tree must be notched.

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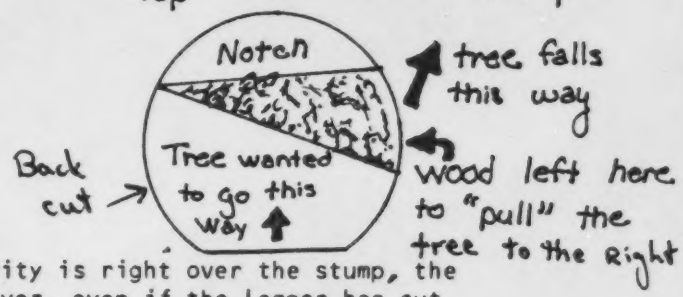
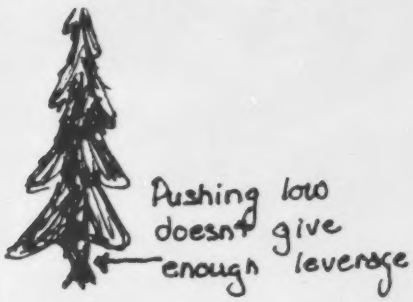
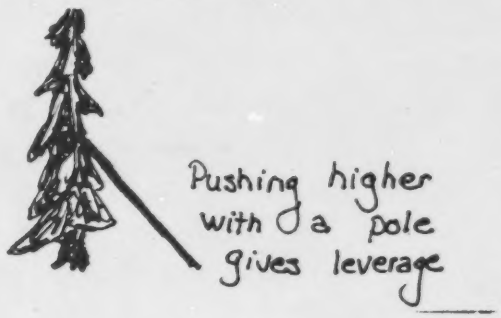
The back cut can be on an angle downward. If a tree is leaning one way, and the logger wants it to fall a bit to the side, the logger can leave wood on the desired side, and this will "pull" the tree sideways .

Top view of a stump



If a tree's center of gravity is right over the stump, the tree might need help in going over, even if the logger has cut far enough. This can be done with a long stick from the back side of the tree. This is safe, and the higher up on the tree the pole is pushed, the more leverage the logger has. It is very dangerous to cut a tree all of the way through. Once it is cut completely from the stump, it can jump off and go anywhere.





Frozen trees in wintertime are more brittle, and tend to snap once they lean. Summertime the wood is more elastic and is safer to knock.

There isn't much to knocking trees, but being able to knock accurately (getting them to "pull") is something to be proud of. Being able to knock them safely is something to be glad for.

SCIENCE OF CUTTING DOWN TREES

Suggested activities

The only way to do this is to do it. It isn't really a class activity, but a demonstration could be given by a villager who knows how.

On a small tree it could be shown what happens when the notch is nothing but a single cut.

If the day is chosen right, the effect of wind on the tree's fall can be shown.

On a small tree, students could discover the leverage of pushing high up on the tree with a pole instead of pushing low.

It would be good if a demonstration could be given on getting a tree to "pull" to the side. This is more easily done with birch on a hillside.

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Student response to "Science of cutting down trees"

Draw a tree whose center of gravity is leaning to the right.

Why would a live tree with branches be pushed harder by the wind than a dead tree? (Use the words "surface area" if you can.)

Draw a picture showing how a narrow notch in knocking a tree will pinch.

Draw a picture showing how to cut a tree so that it will "pull" in a direction different from where it wants to go.

Why is it dangerous to cut a tree all of the way through?

Why are trees more dangerous to knock in the winter than in the summer?

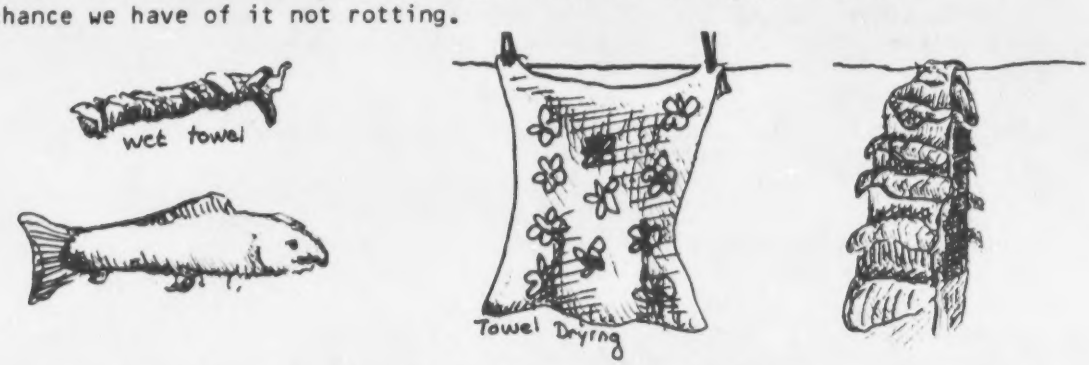
the smudge pot. While blowflies don't like smoke, the smoke doesn't bother the maggots much, so the idea is to keep the blowflies from the fish with the smoke. Who gets up earlier,us or the blowflies?

You might notice that most smokehouses are built near the top of the bank, even though this puts them in danger of being bumped by ice. Again, the old folks knew what was going on. On top of the bank there is a good gentle breeze that will help to dry the fish. In a narrow valley, or back in the brush there isn't enough wind to dry the fish.
Next to a creek is also a bad place for a smokehouse, as it is too damp.

The weather is important in fishing. If the weather is nice and dry, our fish will dry with little trouble. If the weather is rainy for a long period of time we could lose some fish. We must keep a good fire going to dry the fish.

Rotting and blowflies are the enemies. Smoking and drying the fish is the only way to defeat both of them.

Cutting the fish is an art. Everyone seems to have his or her own way of doing it, and everyone thinks his or her way is really the best. It is best to talk about cutting without talking about exactly how to do it. Picture in your mind a wet towel. If we hang it on the line spread out in a gentle wind, it will dry really fast. If we bundle the wet towel up and put it in a closed place, it will take a very long time to dry. This is pretty plain to see. When a fish comes to us out of the water, it is just like the bundled towel. It is wet, and it is "bundled" in a neat package. When we cut the fish, what we are trying to do is open the fish up (just as we would spread the towel on the line to dry.) The sooner the fish dries, the better chance we have of it not rotting.



Of course, when we cut fish for dogs and people we cut differently. Dog fish can have all of the bones and be a little sour, and still be okay for the dogs. However, eating fish for people needs to be as free from bones as possible, and MUST be cut in a way that will allow it to dry before it sours. In rainy weather, this means that we will have to cut our fish thinner.

SCIENCE OF CUTTING FISH
Concepts- surface area

If we hung uncut fish in our smokehouses, we would have a terrible mess and smell that would make our fishcamp an awful place.

It is lucky for us that the old timers knew enough about science to show us how to keep fish. For sure, they didn't learn from a book or class, but they were thinking people.

This is said to encourage you to understand the science of cutting fish. You might find that your way of cutting fish is good for sunny weather, but that someone else's way will keep fish from spoiling in rainy weather.

There are two enemies of the fish cutter:
1) rot and
2)blow flies

We are lucky that what we do to battle one of them works against the other one too.

Rotting is caused by bacteria and enzymes in the meat of the fish. While the fish are alive, bacteria are a part of the fish and do a job in the fish. Once the fish is dead, the bacteria and enzymes take over.

Two main things are needed for a fish to rot:

1)a fair amount of heat-Freezing would prevent rotting if we had a big enough freezer to hold all of our fish.

2)water- This is the one we can take away and defeat the rot!

If we could take the heat away, it would be really nice, but we can't afford to do this. But if we take the water away (by drying) then the fish will keep without smelling until we need them.

HOW LUCKY we are. Taking the water from fish also defeats those miserable blowflies. The maggots cannot come out of the egg stage alive IF there isn't enough water.

Let's talk a minute about the smokehouse. Dry is what it has to be! A smokehouse built on damp ground will tend to have mouldy or sour fish. A smokehouse with a leaky roof will have rotten fish. Even if the fish is too dry to rot, if it is made wet again by rain, then the blow flies will lay their eggs successfully on the fish. Everyone has had "white rain" in their smokehouse sometime or other, but certainly no one is proud of it. Old timers used to be proud if there were no maggots on their fish.(They didn't have aluminum roofing and plywood either).

When we first put fish into the smokehouse it is wet. Rotting is a slow process, but there is nothing slow about blowflies. We have to come up with something that will keep them out. The old timers showed us that too, and they weren't lazy to get wood for

The whole idea behind cutting fish is to increase the surface area so that it can dry fast enough. If we leave too much meat on the backbone we are wasting good fish. If we take too much meat from the backbone then the fish might not dry fast enough. How thick is too thick? There is no real answer to that. How dry is your smokehouse? How dry is the weather? How full is your smokehouse? (a full smokehouse will have less fresh air circulating than an empty one). There are so many things to think about that if anyone says his way is the only way, he doesn't really know what's happening.

Again, dogfish can be thicker, as we don't worry about the sour taste for dogs. Eating fish for ourselves must be cut so that it will not be sour.

SCIENCE OF CUTTING FISH

Suggested activities

Cut a small fish into three pieces. Put one in the freezer. Cut one so that it has lots of surface area to dry from and hang it to dry. Leave the other in a warm place uncut. As soon as the uncut one gets sour, make note of it with the students, and get rid of it. Compare the other two. Which would taste better? Which is easier to store in large amounts?

Get samples of different people's fish throughout the village. Being careful not to insult someone's cutting style, compare them. Compare eating fish and dog fish.

Try to find some dog fish that has evidence of maggots. Where were they before the fish dried?

Look at or discuss the different smokehouse locations in and around the village. What do they all have in common? How far from the river, how much brush around them, how dry is the ground?

Student response to "Science of cutting fish"

What are the two bad things that can happen to fish we are trying to dry?

What are the three things needed for fish to rot?

Which of these is easiest take away?

Describe what a place would be like for a good smoke house location.

The whole idea behind cutting fish is to increase what?? Why?

SCIENCE OF SKATES AND STEEL SLED RUNNERS

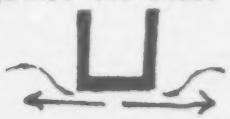
concepts- surface area, friction

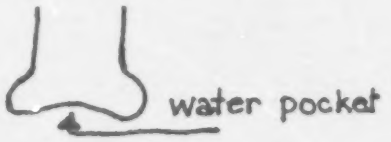
Almost every Alaskan student who has lived near a hill of any kind has coasted down the hill on a sled. A close look at the sled runners shows that they aren't flat on the bottom. There is a very good reason for this.

Pressure makes heat. We can tell this when we pump up a basketball (the pump gets hot) or when we make snowballs (pressure melts the snow and turns it to water).

As we travel down the hill on our sled, our weight is spread out over a very narrow area of the runners. The pressure makes heat. The heat melts the snow, and we are actually sliding on a thin layer of WATER. This seems impossible when the temperature is below freezing, but it is true. Did you ever notice how slippery it is spring time when there is water on top of the ice? It is much more slippery than when the ice is frozen solid. The same effect is created by the sled runners, only the pressure of the runners causes the heat, that melts the snow, that turns to water, that lets the sled slide with very little friction to the bottom of the hill.

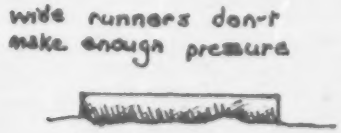
This explains why the runner isn't flat. If it were, the water would run out the sides, and the metal runner would drag against the snow.

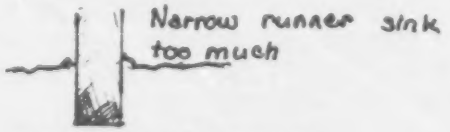




But as it is, the water is trapped under the runner, and the sled slides easily. Many sled experts (most are under 12) have noticed that sleds slide better with a bigger load. This is because greater pressure makes more heat, which makes more water, which lets the sled slide easily.

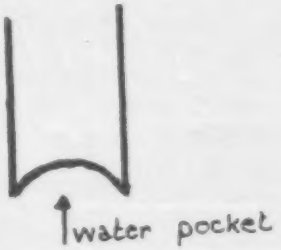
If the sled runners were wider, the sled would be able to stay up on top of the snow better, but the pressure of the rider would be spread out over a greater surface area, and not enough heat would be generated to make a film of water.





If the runners were too narrow, there would be enough pressure to make heat and water, but there also would be too much pressure for the snow to support, and the runner would sink deeply.

Ice skates work exactly the same way. We don't skate on ice! We skate on a film of water! The skate blades can be narrow because the ice is hard enough to keep it from sinking in. The great pressure that is made by our weight being put on those narrow blades makes heat. The blade is shaped like -



and the water is trapped under the blade. If the skate blade were wider, it wouldn't make enough heat to make water.

While this sounds rather crazy, pressure has been making heat, and people have been skating and sliding on water for a long long time.

SCIENCE OF SKATES AND STEEL SLED RUNNERS
Suggested activities

Look closely at the runner on a child's sled. Is it flat on the bottom?

Let students put pressure on snow, but with a board or something insulating their body heat from the snow. Does the snow pack and become wet from the heat that the pressure made? If not, then it might be best to let them put their pressure on a smaller surface area.

Try running a child's sled in soft snow. What happens? Time a run down a hill with one light student.Time a run down the hill with two heavier students. There are a few variables involved here, but it should be clear that the increased weight made increased pressure, which made more water under the runners, which reduced friction.

Look at the runners on a pair of ice skates. Is it clear that a chip in the side of the blade would allow the water to escape from the pocket under the runner?

Student response to "Science of skates and steel sled runners"

Does pressure make heat? If so, give an example from your life that might be able to prove this.

Which is more slippery- ice, or ice with a little water on top of it?

Draw a picture showing how the pressure of a sled runner makes water and traps it.

Why does a sled slide with less friction when the load is heavier?

Why would runners that are too wide be no good?

Why would runners that are too narrow be no good?

Draw a picture of an ice skate runner and how it traps water.

Do we skate and slide on water or ice and snow?

SCIENCE OF DOG SLEDS
Concepts- friction, surface area

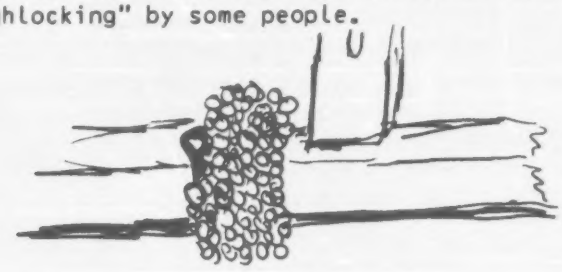
If some great computer expert put all the information about the demands on a sled into a computer and commanded the computer to design a sled, if he was lucky.....he would end up with something almost as good as the sleds the old timers built. The old folks didn't use big words to describe the process of building sleds, but they did have the knowhow. Technology has brought new things like plastic runners and good steel brakes, but the design of the sled has never been much improved.

The dogs are pulling against three things:

1) friction against the runners
2) inertia of the load
3) keeping the sled on the crooked trail

The runners of a sled are very important. If they are rough or made out of material that is hard running, then the friction of the runners against the snow will make the dogs tired very fast. If the snow was always the same, then it would be easy to pick the perfect set of runners, but the nature of snow changes with the weather. A runner that is easy running in warm weather, like steel, is terribly hard running in cold weather. The old timers didn't have plastic, so they used iced wood in cold weather. This was as friction free as plastic is today, but as soon as the ice wore off or the weather warmed, the sled became hard running. The old timers used very hard steel for mild weather. Having two different kinds of runners for different weather worked pretty well most of the winter, but in March they often had to change back and forth or put up with a hard running sled. Today we have a choice between steel and many kinds of plastics. While racers get fussy about their runners and the weather and snow conditions, most village people get a set of plastic runners that will last and are glad that they don't have to switch back and forth between steel and wooden runners.

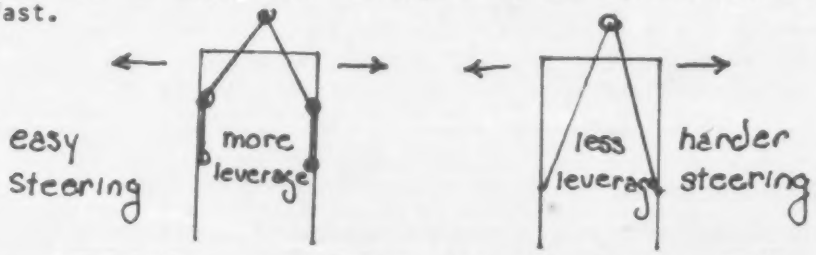
When a heavy sled is going downhill, it can be dangerous for the driver as well as the dogs. An experienced person will often take the time to wrap a dog chain or two around the runners to increase the friction. This usually will slow the dogs and sled enough to make it safely to the bottom. It is called "roughlocking" by some people.



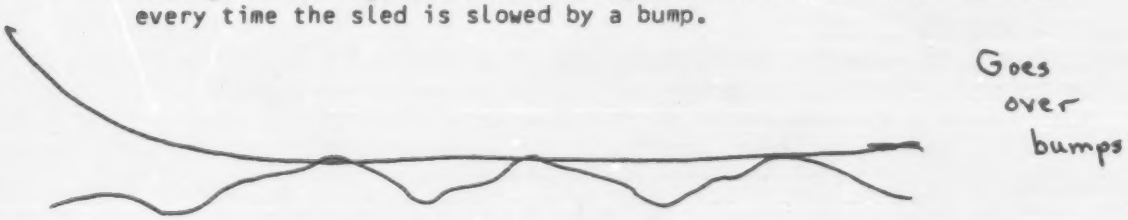
Everyone knows that it takes energy to get a heavy thing going and that it takes energy to stop. A heavy sled has more inertia

than a light one. Everyone who has run dogs has flipped a sled going downhill, and knows that a loaded sled is harder to stop than an empty one. A main part of being a good dog team handler is involved in knowing when to push and steer. The smoother the sled runs, the better it is for the dogs. Jerking and uneven running of the sled breaks the dogs' rhythm and tires them quickly.

Turning the sled takes energy from the dogs, and this is why most mushers will put their stronger dogs close to the sled. Running off the trail takes lots of energy to get back on, so prevention is the best approach. Having the strongest dogs close to the sled will give the power necessary to keep the sled on the trail most of the time. If the bridle is connected as far forward as possible on the sled, then the dogs will have lots of leverage to pull the sled around corners. If the bridle is connected too far back, then the dogs will exert great effort and tire fast.



A long sled will tend to go over the tops of bumps. This will give the dogs a smoother ride, with less inertia to overcome every time the sled is slowed by a bump.



A longer sled tends to be heavier though, so there is a point where a sled can be too long and too heavy with too much inertia. A longer sled is harder to turn. A longer sled has more surface area on the runners and will stay on top more while breaking trail. A shorter sled will give a jerky ride for the dogs but is lighter and has less inertia to overcome when there are changes in direction or speed. A shorter sled will sink much more when breaking trail in deep snow. Actually, there is no perfect sled. Snow conditions, changes in load, different kinds of dogs, and different kinds of handling all enter into the decision of what kind of sled to buy or make. Hopefully understanding the science of it will help in making a wise decision.

SCIENCE OF SLEDS
Suggested activities

Try pushing a sled that has old iron runners, or some other rough runner. Compare this with a sled with plastic runers.

Try roughlocking a runner with a dogchain. Try it with the chain wrapped in a ball around the runner, and again with the chain spiraled around the runner over a distance.

Try pushing an empty sled, and then a loaded one. The difference in inertia should be obvious.

Make a temporary bridle that is tied about in the middle of the sled. Try pulling the sled around. Is it clear that a bridle attached more towards the front has more leverage to steer?

If possible, try a long sled, a short sled and a medium sized sled, and compare them for smoothness of ride on a rough trail, and ease of handling.

Student response to "Science of sleds"

What are the three things that dogs are pulling against when they pull a sled?

What kinds of runners did the old timers have for warm and cold weather?

Why have we changed to plastic?

Describe roughlocking. Draw a picture if you want to.

Describe inertia as it relates to a sled, and the dogs pulling.

Why is a longer sled smoother on the dogs? Draw a picture if you want.

Again look at the three things that the dogs are pulling against from the first question. List them again, and tell as much as you can about how to make the dog's job easier.

SCIENCE OF SNOWSHOES
Concepts- surface area

Snowshoes have been around our villages for a longer time anyone can remember. The old timers really understood snowshoes, how to make them, and how to make different kinds for different conditions.

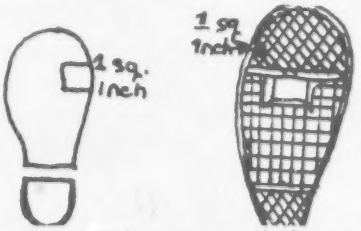
The obvious idea behind snowshoes is to keep us up on the snow as we walk.

But is it really necessary to have large snowshoes when the snow is hard packed? Is it necessary to have large snowshoes when the snow isn't really deep? Will small snowshoes do a good job for us if the snow is powdery?

It is easier to understand this for now if we talk about mud rather than snow, as the ideas are the same and we sink more slowly into mud. It's easier to picture in our minds. The heavier we are, the greater the pressure is that we exert downward. If I step out of the boat onto mud, I will sink deeply into the mud. If I put a board or some brush on top of the mud and step on either of them, my weight is spread out. I won't sink much at all. A heavier person will sink more, and a lighter person will sink less, but it is plain that our weight isn't the only thing that determines how deeply we sink down.

The pressure we exert downward can be talked about in pounds. The other thing we must think about is "How many square inches are those pounds being spread over?" If I put my weight on a 2x4 that is 8 feet long, my weight will be spread out over about 760 square inches. If this is on top of mud, I won't sink much at all.

If I put my whole weight on the same 2x4, but this time on the end of the 2x4, the same weight will be on 8 square inches, and I will slowly sink into the muck.



So we see that the weight exerted downward is important. The greater the weight is, the more pressure it makes, but the really

important thing to think about is how many square inches, or what surface area is the weight spread over. Divide your weight by 24". This is about how many pounds per square inch you put on the floor. Divide your weight by 750. This is about how many pounds per square inch you would put on the snow with a standard pair of 10"x56" snowshoes. Back to snowshoes. Snowshoes need to be bigger if:

1)the person is heavier

2)the snow is softer

The disadvantages of big snowshoes are that they are heavier and they are hard to use in thick brush. Snowshoes can be smaller if:

1)the person is smaller

2)the snow is crusted or windblown enough to be tightly packed

As snowshoes aren't cheap, we have to decide which kind we want. Snowshoes that are too big are harder to handle. Snowshoes that are too small are exausting to use because the user sinks too deeply. Most people think that it is better to have snowshoes that are too large than too small. Over the course of the winter, all kinds of snow conditions are met. The worst kind is when we sink past our knees even with snowshoes on. We can't change our weight too easily, but we can change the surface area that our weight is spread over. Larger snowshoes let even a big man sink no deeper than a child.

SCIENCE OF SNOWSHOES

Suggested activities

This can be done in winter with snowshoes or in spring or fall in soft ground. Compare how much a light person sinks against how much a heavy person sinks.

Spread brush on the mud or snow. How does this affect how far the people sink into the ground? Put a small board down and let a light person step on it. How far does this person sink? Let the same person put his/her weight on the end of the board. How far does the person sink this time? What does this say about psi? Try different places, with softer and harder mud or snow. Put more brush down.

Let students divide their weight by the approximate number of square inches on their feet to find psi without snowshoes. Let them divide their weight by 750 to find psi with snowshoes.

Student response to "Science of snowshoes"

The idea behind snowshoes is what?

Who will sink more deeply into mud, a heavy person, or a light person? Why?

Which will sink more deeply into mud, a person who just jumps out of the boat, or a person who puts brush down on the mud first and walks on the brush? Why?

Which is better for soft powdery snow, big or small snowshoes? Why?

Which is better for hard packed snow, large or small snowshoes? Why?

Do you think that the old timers could have lived through the winters without snowshoes? Why or why not?

SCIENCE OF AIRPLANE FLOATS
Concepts- surface area, friction

Almost every Alaskan has flown in a float plane and thought little of it. However, floats are pretty special. They must fly as well as float. They must be able to get the heavy plane off of the water in smooth and rough conditions, and they must be able to stop in a fairly short time. It would be no good at all to have floats that let the plane glide on the water for long distances and bump the far bank of a lake on landing.

Floats have the advantage in Alaska of being able to land anywhere there is water deep enough and long enough for take-off and landing. Floats have the disadvantage of being very expensive. They also put a great deal of drag on the plane, slowing it down by about 15 miles an hour. Even if a float plane is the same cost per hour as a wheel plane, it will cost more to make a trip in one because it takes longer to get to the destination.

Airplane floats must be watertight. As they could get a leak on the rocky shores of a lake or river, they are made in sealed sections. If there happens to be a leak in one of the sections, the whole float will not fill up and sink the expensive plane. The float is shaped like this on the bottom.....

When the plane needs floatation, the whole float is in contact with the water, but as the plane starts to take off, only the front part is in contact with the water. This way, there is a minimum of friction with the surface of the water. If the bottom of the float was flat, it would climb up on top of the water much more easily, but the flat bottom would pound the airplane terribly if it was landing in waves. The V shape of the bottom prevents the float from climbing up easily, but it cuts the waves and makes a smoother landing and take-off. The V shape also sinks more on landing and allows the plane to slow down in a reasonable time.

How does the float fly? The float isn't designed like an

airplane wing, but it is designed so that the pressure under the floats is great enough to lift at least their own weight. It must be remembered that the floats drag terribly.

Commercial jetliners have wheels that pull up into the body of the plane to avoid drag. Pilots of float planes wish that something like that could be done for floats, but it isn't practical.

SCIENCE OF AIRPLANE FLOATS
Suggested activites

Go look at a pair of floats if there is one in the village. It is hard to have a controlled experiment with a model set of floats. Test equipment just isn't available. Discussion is perhaps the best way to handle this section. Do the comments in the section on airplane floats matchthe student's experience and knowledge. Why are many air taxies trying to get away from floats?

Student response to "Science of airplane floats"

Floats are good because they can land on lots of places in the Alaska bush, but they have two disadvantages. What are they?

Why are the floats made in sealed sections?

Draw the shape of the bottom of a float looking from the side.

Why is it like this?

THE SCIENCE OF GUNS
Concepts- friction, action-reaction

Guns have been around the country for quite a while, and many people have worked to make better guns, but for the most part, guns are a way of throwing rocks (lead) accurately. The rifle, shotgun or pistol are just a way to control the time and direction that the bullet takes off.

What we call"shells" are actually three parts·

1) the lead that flies out
2) the powder and primer that push the lead out
3) the casing, which holds the other two parts together until the right moment.

Rifle shells are in many sizes and shapes. Some are for shooting at distances with a light fast bullet- like .270 or .243. Some are for shooting heavy bullets at slower speeds, but with great impact- like 30-06 or .444 Marlin. Some are smaller and slower for small animals up close like .22. Which one is best? There is no way to answer the question without knowing what the gun is to be used for. There is no use to shoot a moose with a .22 (though it is foolishly done sometimes), and there is no use to shoot a grouse with a 30-06. We all have that much sense. Somehow most folks think that the gun they have is the best (unless they have just missed an animal, and then the gun they used to have was best.)

The lead part of the bullet is weighed in grains. The lead can be as light as 55 grains in a .22 or as heavy as 240 grains in a Marlin .444. Different weight bullets are often made for the same gun. Example: 30-06 is made with 130 to 220 grain bullets. Usually it is said that the heavier bullet is slower but has more impact up close, and the lighter bullet is faster and has more impact far away.

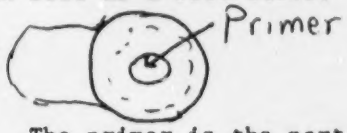
The hardness or softness of the bullet makes a big difference. If a bullet is too soft it will splatter as soon as it hits the animal and will do surface damage, but won't penetrate enough to do damage in the right places. If a bullet is too hard, it will go into an animal and zip out the other side without doing much damage. In the perfect situation, the bullet should go into the animal and mushroom before it hits the heart or lungs. While this is all true, it is plain that a bullet that is too hard for a chest shot on a moose is too soft for a shot in the hip. Certainly there is no perfect bullet.

What we are after here is an understanding and a fair idea of what kind of bullet to choose. It is better to shoot a smaller animal with a softer bullet and a bigger, or thicker skinned animal with a harder bullet.

The powder in a rifle is specially made to burn all the way down the barrel. If the powder burned too fast then it would push for the first half of the barrel length, and drag on the bullet for the last half of the barrel length.

If the powder didn't burn fast enough, then the bullet would leave the barrel before the powder had finished pushing. Power would be lost. The greater the surface area of the powder, the faster it burns. The less the surface area of the powder, the slower it burns. The powder is designed to push steadily down the barrel and to burn right up until the bullet leaves. Powder must also be made to burn cleanly. We couldn't

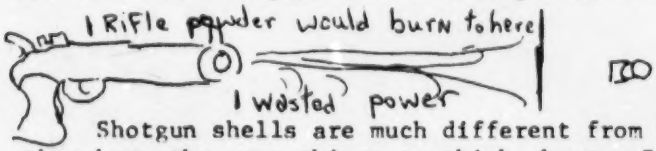
take time between shots to clean the barrel if the powder burned with as much soot as a wood stove.



The primer is the part of the bullet that the firing pin hits. It works like a cap in a cap gun. Pressure and friction within the primer make enough heat to burn the material in the primer. The primer is hot enough to start the powder burning.

There are enough stories in each village to convince any intelligent student that it is foolish to mess around with shells. It is good to be curious about life and the world, but no one needs to say anything about being too curious about shells. They are dangerous.

Pistol shells are different from rifle shells mostly because the powder must burn faster than it would in a rifle. If rifle powder were used in pistol shells it would never have a chance to push the bullet far, as it is made to push the full length of a 22" or 24" barrel.



Shotgun shells are much different from rifle shells in appearance, but they have the same things to think about. Instead of having one lead bullet, there are a few balls of lead (like in 00 buck shot) or many, many little shots (like in #6 shot). Mostly the smaller shots like #6 are used on lighter birds close up (like spruce chicken), and the heavier shots like #2 are used for larger birds farther away (like geese). Nowadays, there is a shot cup that holds the shot all the way down the barrel and falls away as it leaves the barrel.

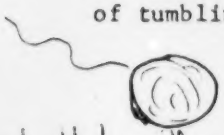
The plastic shot cup reduces friction between the shot and the barrel. This lets the barrel last longer, and lets the shot leave faster with fewer shots damaged during the blast out of the barrel. Shotgun powder is made to burn down an average barrel length. Sometimes we wish for a really long barrel to reach those birds that are a little too far away to shoot. But a longer barrel would only slow down the shot unless there were a longer burning powder in the barrel.

Guns have been made, improved, and worked on for quite a while, but they are basically of four different kinds:

1)bold action
2)pump
3)automatic
4)single shot

There is good and bad about all of these, and the fact that they are all being made yet proves that none of them is greatly better than the others.

Really old style guns had smooth barrels and round bullets. They weren't very accurate. It was learned that making twisted grooves in the barrel would spin the bullet. As long as the bullet is spinning, it isn't likely to tumble and wander around in the wind. A longer slimmer, smoother flying bullet can be made if there is no danger of tumbling.



a bullet without spin wanders

a spinning bullet flies straighter & smoother

How hard a gun kicks depends on a couple of things. When we first learn to shoot "How hard does it kick?" is usually our first question. The power of the shell makes a difference. Obviously, a 30-06 will kick more than a .22. The weight of the gun also makes a difference. A light gun has less inertia and will pass the shock on to the shooter. A heavier gun has more inertia, and will pass less of the shock to the shooter. Pistols are known for kicking hard. They must force the bullet out of the barrel in a very short time. While a rifle isn't gentle, it can push the bullet along more gradually and therefore kick less than a pistol.

The sights of a gun are lined up with the barrel so that wherever the sights point, the barrel is also pointing. That is clear enough. If the sights are out of line, it is possible in some kinds of guns to take the bolt out and look down the barrel. If the sights and the barrel are aiming at the same thing, then the sights are on target. The best way to do this is with the gun on a stump, pointing at something about 100 yards away.

Do the barrel & sights point at the same thing?

Open sights are better than scopes for some reasons. They are cheaper. They are better for shooting close in the brush. They can't fog like a scope. Scopes are better for other reasons. We can see accurately for longer distances. A big advantage of a scope is that it requires our eye to focus on one place only- the lense of the scope. Iron sights make our eyes focus in three different places:

1)close- the rear sight
2)a little farther- the front sight
3)at a great distance- the target

This puts demands on our eyes that is hard to meet. But scopes fog, get bumped out of sight easily, are heavier to carry around, and cost more. Very seldom is there a time when we didn't wish for one or the other for different situations.

The trajectory of a bullet is the path it takes. We wish the bullet would travel straight to the target. But all of the time it is going away from the shooter it is dropping. This is why we have to raise our sights when the target is over 100 yeard or so. Faster bullets drop less in 100 yards than slower ones, but the weight of the bullet doesn't make any difference at all. Heavy things drop the same speed as light things if the surface area is the same.

While shotgun shots leave the barrel with great force, the wind resistence against them is really great, and they slow down quite rapidly. Shooting a 30-30 and a shotgun over a small lake will make this quite plain. The shotgun shots are held back so much by the air. Rifle bullets are long and slim and are spinning.

Many people consider themselves experts on guns and take great pride in their guns and their knowledge of guns. These people have a great hobby. The rest of us need only a basic knowledge of guns and how they work in order to get meat from the woods to our cache.

SCIENCE OF GUNS
Suggested activities

It would be interesting to take a shell apart, but though there is relatively little danger involved, it is not advisable to do it on school time.

Compare the bullet weights and sizes of as many shells as are available. Read on the boxes how much each bullet weighs in grains. Compare the hardness and softness of the bullets. Some containers tell the story of the hardness or softness of bullets.

If you can safely do it, shoot a .22 rifle, and then a .22 pistol. Compare the flash out of the barrel. This would be easier when it is dark. Does this show that a pistol needs faster powder?

An interesting thought is the question of "Where does the air come from to burn the powder?" The powder has sulfur in it that takes the place of oxygen in the burning of the powder. Scrape some .22 bullets with a fingernail. Is the wax visable? What is the wax for?

If you can, shoot a shotgun and rifle side by side by a lake or up the river if it can be done safely. Notice which goes farther. If there is a cross wind, notice how much the shotgun shots drift with the wind.

A very good experiment can be done with a bicycle wheel if it is off of the bicycle. Get a student to hold the axle on either side of the wheel, and let another student spin it. The tremendous force it takes to tip the wheel will quickly be noticed. This explains why a bullet is made to spin to keep from tumbling. Compare the kick of a .22 with that of a 30-06, with that of a 12 gauge shotgun.
Compare, if possible, the kick of a light 12 gauge with the kick of a heavy one. Is the difference in inertia noticeable?

Student response to "Science of guns"

What are the three parts of what we call "shells"?

The lead part of a bullet is weighed in what kind of measure?

What will happen if we shoot a bullet that is too soft?

What will happen if we shoot a bullet that is too hard?

What would happen to the power of a rifle if the barrel was too long?

If you wanted powder to burn faster, would you make its surface area larger or smaller?

How is pistol powder different from rifle powder?

Which shotgun shot is bigger #2 or #6?

What does the plastic shot cup do in shooting the shotgun?

There are four kinds of action for rifles and shotguns. What are they?

Which of these do you prefer? Tell why if you have good reasons.

Why are bullets made to spin?

Why are open sights better than scopes?

Why are scopes better than open sights?

What is the trajectory of a bullet?

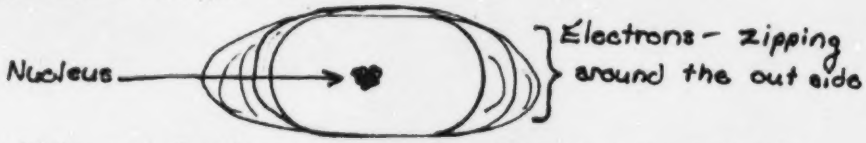
Why do we have to raise our sights when the target is far off?

Why do shotgun shots slow down much faster than rifle bullets?

SCIENCE OF GENERATORS

Electricity is becoming more and more important to village Alaskans. We have all seen generators, and yet we often look at them as if they were magic. There is no magic involved, just a basic understanding of magnets and electric forces.

Scientists say that all of the world is made of matter and energy. They also say that matter is made of atoms and these atoms look something like this-

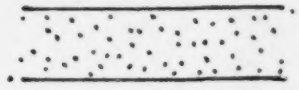


The middle part is the nucleus. The parts that are spinning around the outside are electrons. The scientists say that the electrons have a charge, like a magnetic charge. Each electron has a small charge and is like the south pole of a magnet.

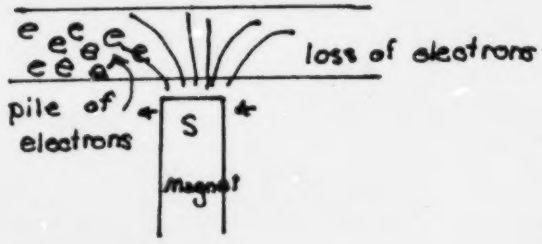
Most people have played around with magnets and have seen how two north, or two south poles can push each other away. A north pole and a south pole will attract each other.

Since you know that two south poles will push each other away you can follow this in the picture and in your mind.

When there is no magnet around, the atoms in the wire all have balanced charges. They are all balanced as long as no forces are working on them. If we pass a magnet past the wire, we know that two south pole charges will push each other away. The magnet will push away anything that has a charge like a south pole. In the atoms of the wire, of course, there are atoms that have electrons with a charge like a south pole. The magnet will push these away if it can.



No magnet. All forces are balanced.



So, as the magnet passes by the wire, it is actually ripping off electrons from the wire. So its magnetic force is "plowing" the electrons ahead of itself. THIS IS ELECTRICITY. It is that simple. Of course, in a generator, there are many wires so there can be more electrons ripped off. As these electrons are ripped off they pass down the wire trying to escape the strong force of the magnet. It is this force that can do work for us in a motor or in a light bulb.

For a long time, scientists thought that the same electron that got ripped off in the generator wires would race all of the

way down the wire and come back to the generator. It wasn't too long ago that they discovered that the electrons bump each other. An electron will move over to the next atom and bump the electron from that atom. The electron that gets bumped will move over to the next atom and bump its electron. This continues down the wire. This means that an electron doesn't race down the wire after it has been ripped off of its atom. The electron just moves in on its neighbor, and its neighbor's electron has to move in on its neighbor, and so on down the wire.

This helps us understand why electricity can pass through some materials and why it can't pass through others. Materials that electricity can pass through are called "conductors". They don't hold on to their electrons too hard, and their electrons are easily bumped. Materials that can't conduct electricity much are called insulators. They hold tightly to their electrons and refuse to have their electrons bumped. Copper is a good conductor, and plastic is a good insulator. This is why most wires are copper covered with plastic. The copper allows the electrons to pass freely from one place to another, while the plastic insulator keeps the electrons from side tripping to some place that we don't want them to go.

Of course, scientists spend much time trying to make better generators, but the idea behind all generators is the same. A magnet rips off electrons from a wire, and forces them down the wire so that they can do work.

SCIENCE OF GENERATORS
Suggested activities

This is hard to do without a small generator of some kind to take apart. The point should be made that a generator has a permanent magnet rotating in the center of the wrapped wires, and an alternator has an induced magnet rotating in the center of the wrapped wires.

Student response to "Science of generators"

Scientists say that the whole world is made of what two types of things?

The parts that are spinning around the outside of the atoms are called what?

When we explore magnets we find that two north poles will do what to each other? Two south poles will do what to each other?

When there is no magnet around, the forces in a wire are what?

Describe what happens to the electrons in a wire when a magnet is passed by the wire. Use a picture if you want.

Once it is ripped off, does an electron race all the way down the wire, or does it bump an electron from the atom beside it?

Is it a good conductor or a good insulator that has loose electrons to be bumped?

Why is copper a good conductor?

Why is plastic a good insulator?

SCIENCE OF CASSETTE AND RADIO SPEAKERS

Almost every house in every village has a speaker or two (or three or four). While speakers aren't too hard to understand, they can't be figured out just by looking at them.

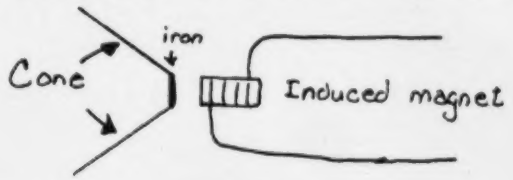
Everyone knows that there are two kinds of magnets:

1)permanent magnets that are always a magnet until they are heated too much or pounded too hard

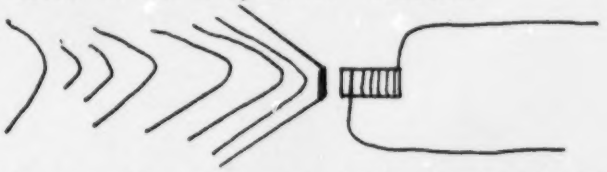
2)induced magnets which are pieces of iron wrapped in wire that are magnets when electricity is passing through the wires and are not magnets when electricity is not passing through the wires. Speakers have induced magnets. Induced magnets are handy because the stronger the electric current is, the stronger a magnet it becomes.

Another understanding that is needed is that sound is waves in the air. Anything that will make waves in the air is a source of sound. Note: sound doesn't travel only through air. It can travel through other materials too, but here we will talk about air only.

A speaker is made of a few simple, but well designed parts. There is the induced magnet, and there is the speaker cone. The box or case the speaker is in serves a good purpose too.



As the electric current passes through the induced magnet, it pulls on a piece of iron that is on the cone.
As the current through the induced magnet changes, the pull on the cone's iron is changed, causing the cone to shake. This shaking causes waves in the air, which is sound.

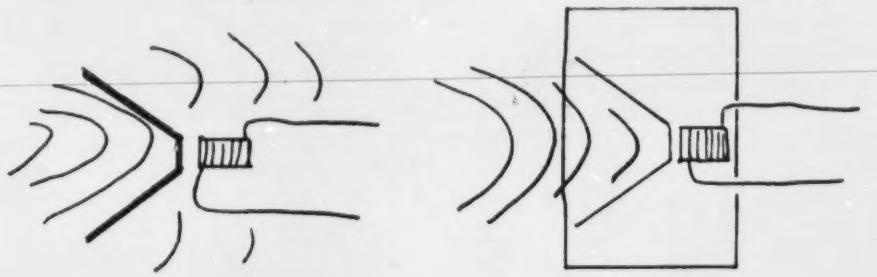


This is fairly easy to understand. What is mind boggling is how the speaker can so accurately reproduce sound. It can give sound so accurate that we can tell the difference between Andy Gibb and the Bee-Gees . We can tell Merl Haggart from Buck Owens. This can only be the result of years of thought and design along with many mistakes and failures.

One of the things that is important about a speaker is that it doesn't take too much electricity to make it work. A speaker that took lots of electricity would have us changing batteries in our radios all of the time. Modern speakers can put out great sounds with a small amount of electricity.

The cabinet or case of the speaker is a very important part. A cabinet that is poorly designed will let the sounds echo and will

confuse the sound getting to the listener. But a speaker without a case is losing lots of its power, as the sound is being spread all over. A speaker is like a piston. It is vibrating back and forth . If it is in a closed place, it will have more power to drive the sound out to the listener. A good part of the price of expensive speakers systems is in the box that surrounds the speakers.



There are many fancy words used in describing speaker systems. Two handy ones to know are:

1) woofers, which are bigger speakers for lower sounds

2)tweeters, which are smaller speakers for higher sounds.

Most stereo speaker systems have both woofers and tweeters

Again, it is easy enough to see how a changing electric current can cause a changing magnetic force on the speaker cone and cause sound. What is hard to understand is how the sound could be made so accurately.

SCIENCE OF SPEAKERS

Suggested activities

Get a speaker from an old radio or casette. Take it out of the cabinet carefully and identify the parts. Hook it up to a radio- either wire can go far into the earphone hole, and the other wire to a ground. The ground can be the + end of the batteries, or any good ground.

Can the students feel the speaker cone buzzing as well as hear it? What happens when someone touches the speaker cone firmly? Why isn't it making as much sound?

Can the magnet attract any large pieces of iron? Can it attract small pieces of iron filings?

Put it in a can. Does it echo too much? Try putting the speaker in many different boxes and containers. What is the differece in them?

Put another large magnet by the center of the speaker cone. Does this change the sound or tone of the speaker?

Try to imagine the speaker in a hearing aid, and what it looks like.

Student response to "Scence of speakers"

What are the two kinds of magnets?

Which kind is in a speaker?

What is sound?

What are the three main parts of a speaker?

What causes the cone to shake?

Does a speaker take lots of electricity?

Describe the best you can what the job of the cabinet is.

Do we want echoes in the cabinet?

Why is a speaker without a cabinet weak?

What is a woofer?

What is a tweeter?

Draw a picture of a simple speaker showing the magnet, cone and cabinet.

SCIENCE OF CASETTES AND RADIOS

While they look and act quite differently in many ways, radios and casette recorders actually work much the same.

They both start with a signal. The radio signal comes to the radio through the air. The casette's signal comes from the casette's tape. That much of their operation is different. From there they are basically the same. The signal that comes to the unit (radio or casette) isn't fit for us to listen to for two reasons:

1) it is too weak
2) it is an electric signal of sorts

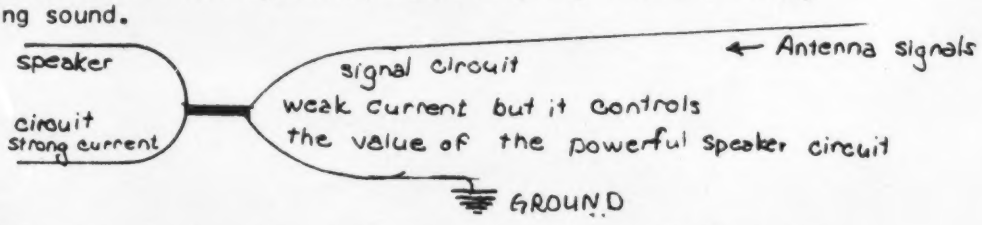
The job of the unit then is to

1) change the weak signal into a strong one
2) change the electric signal into a sound signal to our ears

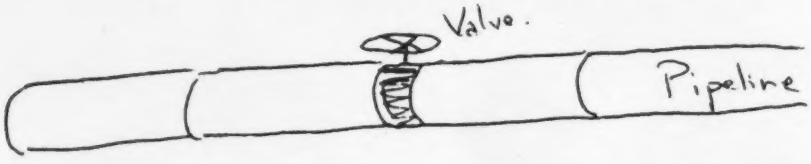
Certainly it is too hard to explain here exactly how this is done, and different companies have their units do the jobs in slightly different ways. But the idea behind all of them is the same.

Picture yourself as working on the Alaska pipeline. You have a job that allows you to control the flow of the oil in the pipeline- wide open, or slightly closed, or almost closed or whatever. You aren't very strong at all, and the weight and force of the oil in the pipeline is tremendous. But you can control the valve that controls the flow of oil. It doesn't take much power to turn the valve.

Now, think of it in this way. There are two main circuits in the casette or radio. One circuit is from the battery to the speaker, and back to the battery. If this current is steady, then there will be no sound, but if the current changes rapidly, then the cone in the speaker is moved rapidly back and forth, making sound.



There is another circuit in the unit. Lets talk about the radio. The radio waves come to the radio through the antenna. They are very weak. They pass through the radio and go down the ground wire to the ground. These radio waves are not steady. They change from faster to slower as the music changes.



The first circuit is like the pipeline. It has a good amount of current going through it. The second circuit is like you, the

Student response to "Science of casettes and radios"

What two reasons are there that we can't hear the signal from a radio or a casette?

What are the two jobs of the radio or casette?

There are two main circuits in the casette or radio. What are they?

What is the job of each of these two different circuits?

Draw a picture of the two circuits. Label them and put the place where the "valve" might be.

How do you think that casettes are erased when they must be erased fast?

SCIENCE OF EATING FOODS
Concepts- surface area

We need food for a very good reason. We need energy, and food has it. Food has stored energy in it that can be held there until it is released by one of three ways:

1) rotting
2) burned in the pan (by a lousy cook)
3)digested by our bodies

The last one is the only one we are interested in at this time.

When we put a match to shavings, what we are doing is putting a little bit of energy into the wood to release the stored energy. What we do when we eat is put enough energy into the food to release the stored energy. The acid in our stomach is the energy supplier.

Let's follow the food from our fork through our system. Our teeth smash and grind the food. Which burns faster, shavings or a stick? Obviously the shavings because it has more surface area to burn on. Our teeth smash and grind the food to increase the surface area. Our saliva also softens the food and makes it easier to slide down our throat. (Who hasn't choked on a mouthful of cookies when Mom walked in suddenly?)

Once the food is in our stomach, the strong acid works to break down the food into small parts. (Did you ever vomit strong burning stuff? This is stomach acid). There are also bacteria in our stomachs that help break down the foods. Some foods, like sugar and bread and rice, are easily digested. They pass out of the stomach first. The meat goes next, and lastly the fats and oils leave. This is why greasy stuff makes us feel full longer. Light sugar and other white foods pass out of our stomach quickly and leave us feeling hungry. (White foods are starches like bread, rice, potatoes, and macaroni.)

The food, as it leaves our stomach, doesn't look at all like what we ate. It passes into our small intestine (long guts). Here the walls of the intestine are rough and have lots of surface area for the food to be absorbed into the blood stream. It is here that the food and the waste are separated. The waste food continues on to the large intestine where as much water as possible is taken from the food. The food, however, goes into the blood stream. Some of it is used right away, but there is a need for a place to store the food. This is the job of the liver. The liver will store the food until it is needed by the blood to supply the muscles.

Without the teeth, the chunks of food would be too large for the stomach acids to work on. Without the stomach, there would be no place to store the food for breaking down by the acids and bacteria. If the food were not broken down by the stomach acids

and bacteria, then it couldn't be used in the small intestine. Without the small intestine there would be no good place for the food to come in contact with the blood. The food would have no good way to get to our muscles. Without the large intestine, there would be a great waste of water from the body, and we would have to drink lots more water. Without the liver, we would get terribly excited as the food got into our blood in a huge rush and would be terribly tired as the food's energy was used up with no stored energy. We would have to eat a cracker to walk across the room, and drink juice to chop 3 sticks of wood, and eat steadily through the day to supply our blood with a steady supply of food.

All of the parts of our body do a good job. Without one of them, the whole system would not work well at all.

SCIENCE OF EATING FOODS

Suggested activities

Try burning a dry stick of wood with one match. Try burning the same stick of wood once it has been carved into shavings. Which is easier? Discuss the idea of increasing the surface area in order to make burning possible. Relate this to chewing food to increase the surface area.

Let students try eating dry bread quickly, and then dry bread that has been chewed and well soaked with saliva. Is the difference because of saliva doing its job of lubricating the throat?

The rest of the science of eating foods would best be handled by discussion. The concept of surface area in the small intestine could be related to the concept of surface area in the lungs for exchange of oxygen. The liver could be related to a battery for its storage function.

Student response to "Science of eating foods"

What are three ways that the stored energy in food can be released?

Which of these is the best for us?

Why doesn't the energy come out of the food as it sits on the table before it's cooked?

Why does food need to be chewed?

Which kinds of foods leave the stomach first?
second? last?

Why is there lots of surface area in our small intestine?

Where is the water removed from the food before it passes from our bodies?

What job does the liver do?

What would life be like without it?